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UNIVERSITY OF ALBERTA

A STUDY OF  
NEST-SITE SELECTION BY ISLAND-NESTING ANATIDS  
IN CENTRAL ALBERTA

by



ROBERT JOHN LONG

A THESIS  
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES  
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE  
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1970  
71

UNIVERSITY OF ALBERTA  
FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "A Study of Nest-Site Selection by Island-Nesting Anatids in Central Alberta", submitted by Robert John Long in partial fulfilment of the requirements for the degree of Master of Science.



## ABSTRACT

Characteristics of 364 anatid nest sites on islands in Miquelon, Hastings, Joseph and Oliver Lakes were examined during 1968 and 1969. The major species of ducks nesting on these islands were lesser scaup (*Aythya affinis*), gadwall (*Anas strepera*), and mallard (*Anas platyrhynchos*).

A comparison of characteristics of nest sites with those of randomly selected points indicated that specific properties of the environment were being selected for.

Ducks appeared to select several sites in which they initiated nests prior to settling on the definitive site.

Physiognomy of vegetation at the nest site appeared to be important in the process of selection. Ducks preferred vegetation between 1.5 and 3.5 dm in height. All species preferred to nest near the edges of patches of dense vegetation. Openings of nests were orientated towards the nearest water or to the south-east. The latter was inversely correlated with the direction of the prevailing wind. The extent of vegetative cover at the nest site was not correlated strongly with either selection or predation.

Interspecific and intraspecific interactions were considered. No overt antagonism was recorded. A passive mechanism for intraspecific spacing was suggested for



ducks. Positive attractions to areas around the nests of Canada geese (*Branta canadensis*) and common terns (*Sterna hirundo*) were noted.

Success of nests was promoted by the insular position and by the presence of common terns.







FRONTISPIECE

"Fidelity" - an incubating  
lesser scaup.





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## I INTRODUCTION

The utilization of specific habitats by birds is influenced both by the physical characteristics of the environment and by the presence of other birds of the same, and different, species.

In early studies of avian ecology the habitat typically used by bird species was characterized by lists of plant species (Bent 1925).

The description of plant associations has continued to be the prevalent approach to habitat studies to date (Keith 1955, Anderson 1956, Klebenow 1968). Odum (1945) and Kendeigh (1945) observed that physiognomy of vegetation was probably more important to birds than species composition. Subsequent studies with passerine species have substantiated these observations (MacArthur 1958, 1960; MacArthur and MacArthur 1961; Hildén 1965; Parnell 1969).

Most researchers working with the Anatidae have failed to consider physiognomic factors. Relative utilization of, and apparent preferences for, certain plant associations as nesting cover have been documented for a number of species (Munro 1937; Bennett 1938; Munro 1939, 1941, 1942; Hochbaum 1944; SOWLS 1955). Mendall (1958) examined the species composition of the vegetation used as nesting cover by the ring-necked duck (*Aythya collaris*) and concluded (p. 103):



"...it seems unlikely that a preference for particular plant associations is of primary importance in attracting birds to certain nesting covers. Rather, it is the physical characteristics of the marsh [habitat], in combination with plant types [physiognomy], that determines the nest locations."

Since physiognomic factors have been largely neglected in subsequent studies, little can be said about the specific factors influencing nest-site selection by ducks.

The influence of intraspecific interactions on the spacing of birds within suitable habitat was discussed at length by Howard (1920). Subsequent studies have revealed that territoriality in birds can assume a variety of forms and functions in different species (Nice 1941). It has been suggested that territoriality may serve the following functions: promote familiarity with the home range; effect dispersion of pairs; facilitate pair formation and nest defence; guarantee a food supply for the young; reduce predation on nests. Hinde (1956) presented a classification of territories based on the nature of their function, and concluded that (p. 343):

"...few statements of universal validity can be made about territory in birds, and it is better perhaps to aim at some comprehension of diversity."

Interspecific territoriality has been described by Simmons (1951) and Orians and Willson (1964). In some instances therefore, interspecific interactions may direct



the distribution of birds in the habitat.

Howard's (1920) concept of territorialism as a spacing mechanism was first applied to anatids by Hochbaum (1944) in his study of canvasbacks (*Aythya valisineria*). Sowl (1955) found that territorialism in ducks was much more variable than Hochbaum had suggested. Smith (1955) and Dzubin (1955) found that territory, as a defended area, was a small portion of an individual's home range that varied in location, and usually centered on the female of the pair. Mendall (1958) described spacing of pairs of ring-necked ducks by what he termed "mutual respect". It is currently realized that the Anatidae exhibit a spectrum of territorial types - from the shoveler (*Anas clypeata*) in which pairs are spaced through aggressive interaction (McKinney 1969) to the undemonstrative lesser scaup (*Aythya affinis*) (McKinney pers. comm.). However, spacing mechanisms are poorly understood for most waterfowl species. Also, little is known about interspecific influences on nest-site selection by ducks although an attraction to nest in larid colonies has been suggested (Hildén 1964, Vermeer 1968).

It is the aim of this study to measure specific biotic and abiotic factors in the habitat used by nesting anatids. Hopefully, this would allow evaluation of the relative importance of the physical properties of the environment, and of interspecific and intraspecific interactions, in directing the selection of nest sites by ducks.

This study was carried out on the islands of Miquelon,





Hastings, Oliver, and Joseph Lakes, all of which are located south-east of Edmonton, Alberta. Islands were chosen because they are often used by large numbers of nesting waterfowl (Hammond and Mann 1956, Duebbert 1966, Vermeer 1967, Dwernychuk 1968). Islands in these lakes supported a variety of plant associations from which the ducks could select.



## II. METHODS

This study was conducted during two summers, beginning on May 23, 1968 and April 28, 1969.

Islands in Miquelon Lake, which were located near base camp, were searched every 2 to 3 and 2 to 7 days in 1968 and 1969 respectively. Those in Oliver Lake were visited every 10 to 15 days both years. In addition, islands in Hastings and Joseph Lakes were searched every 10 to 15 days in 1969. Thorough searches were necessary to insure that a high proportion of nests were located. The search pattern adopted depended upon the type of vegetation present. Islands over one hectare in area, and dominated by herbaceous vegetation were searched systematically. Transects at 7 to 10 m intervals were walked; and the direction of these transects was changed 90° for each search. Small islands were more thoroughly searched. Treed islands were searched less systematically because the nature of the vegetation made the walking of straight transects impractical.

Attempt was made to minimize disturbance of the habitat during searches. Repeated use of the same route was avoided to prevent the creation of trails through vegetation, but where gooseberry (*Ribes oxycanthoides*) predominated, it was impossible to traverse once without leaving a path that was visible at least 14 days later. Such trails may have facilitated predation on nests by providing visual clues to crows and other predators.



As each nest was located, the species of the occupant was identified using characteristics of the flushed duck, the nest, and the eggs. Each nest was assigned a number which was recorded on a nest marker, and on each egg. In 1968, nest markers used at Miquelon Lake were stakes, 80 cm long, and with brightly painted tips. These were placed at 7 to 10 m west of the nest. At Oliver Lake in 1968, density of nests necessitated the use of markers right at the nest. Wooden blocks (4 x 9 x 20 cm) placed flat on the ground were used for this purpose. In 1969, stakes were again used at Miquelon Lake but at all other locations, a piece of bright plastic ribbon was tied to vegetation at 7 to 10 m west of the nest. The constant direction facilitated relocation of nests. Eggs were marked with a felt pen, enabling identification of eggshells found at distances from the nest following predation. Also, recording the number of marked eggs on subsequent nest examinations made it possible to establish whether eggs had been added or lost.

In 1968, histories of individual nests were documented. Data recorded included; rate of laying, clutch size, egg loss, hatching success, presence of eggs of other species, presence of rocks or other foreign objects in the nest, the distance the observer was from the nest when the duck flushed, and the state in which the nest was left by the duck. Vegetation around the nest was identified, and given a cover rating on a scale of 0 to 4, in which 0 indicated a completely exposed nest and 4 one which was totally



concealed.

In 1969, similar data were recorded, and nest sites were characterized further. Vegetative cover was estimated as in 1968, and was recorded photographically with a 35 mm camera. One photograph was taken from directly above the nest, and included an area of  $1 \text{ m}^2$  centered on the nest. A second photograph was taken from the most exposed side, at eye level (1.75 m), 4 m from the nest. For this photograph, a gridded stake (10 x 100 cm) was placed at the nest. Additional photographs were taken as required to characterize the nest site. Contact prints of these photographs were analyzed with the aid of a transparent gridded overlay. Parameters recorded included species composition, height, and the degree of cover.

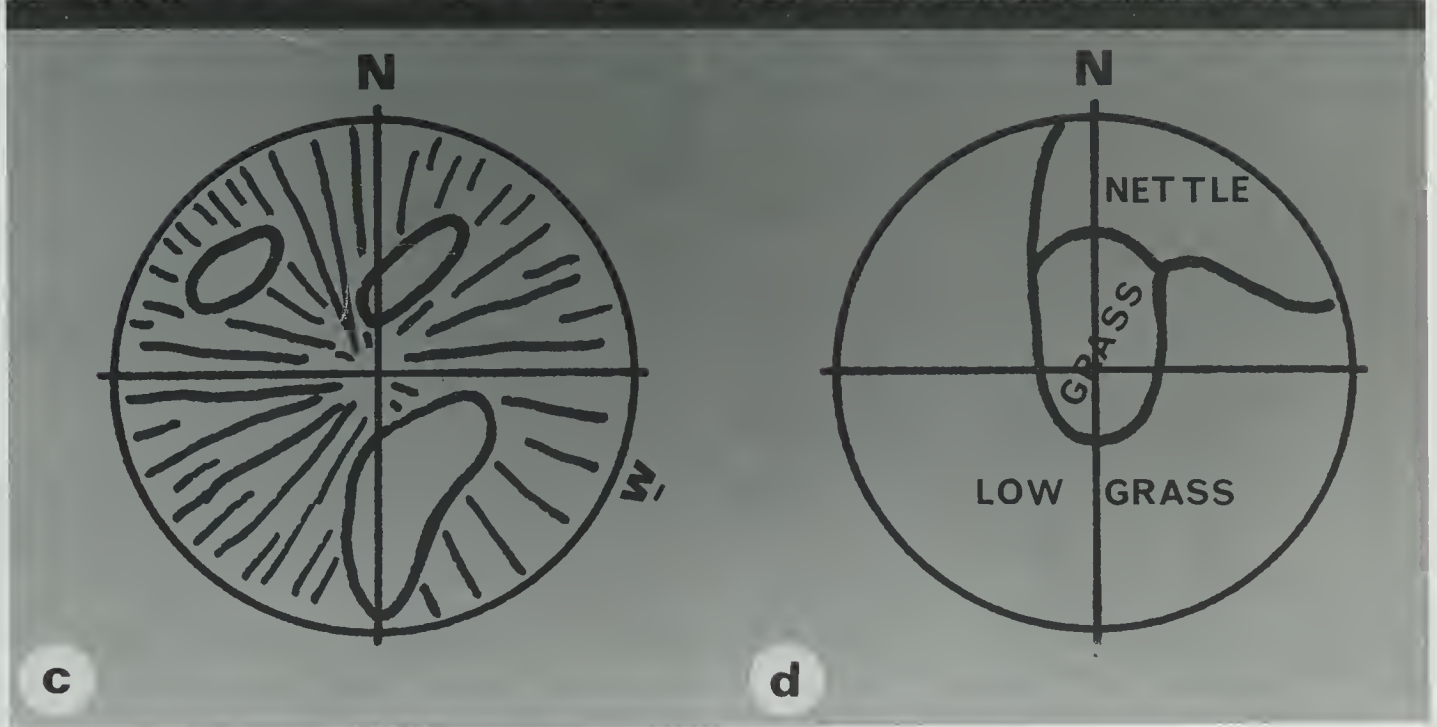
In addition to photographic records, two circular sketches were made at each nest. One recorded the barrier to the view from the duck's position on the nest created by the vegetation and microtopography. The other recorded locations of major plant association interfaces within 3 m of the nest (Fig. 1).

The shading effect of the vegetation at the nest site was evaluated using two light readings. One reading was taken from above the vegetation, at breast height, and the other from directly above the eggs in the nest. A Weston Master IV meter was used; only indirect incident light was measured. To prevent reading direct illumination, a shadow was cast on the meter itself for each reading.

Figure 1. Pictorial data for nest number 69-120.

- a) Vertical view of the nest, including one square meter around the nest.
- b) Horizontal view of the nest site with the gridded stake in position.
- c) Circular sketch indicating the field of view available to the incubating hen. ("W" indicates the direction of nearest water.)
- d) Circular sketch showing major vegetation association interfaces within three meters of the nest.







Because of the periodic timing of nest searches in 1969, many nests were not located until incubation was well under way. The initiation dates of these clutches was calculated using the number of eggs in the clutch plus the age of one of the embryos. To determine the age of the embryo, one egg was collected from each nest on the day that the nest was discovered, and the embryo was preserved in formalin. These were later aged by comparison with specimens of known age.

To allow comparison of sites selected by ducks with sites selected at random, five series of random points were examined on one island of Miquelon Lake during the 1969 season (total of 216 points). For each series, twelve random centers were located by dropping rice grains on a map of the island. Later, in the vicinity of each of these centers, four weights were tossed randomly, and individually, and the point of landing of each was taken as a sampling point. These points were treated as nest sites, and all comparable data recorded.

In order to determine the extent to which "territorial" spacing of drakes was correlated with the pattern of nest placement, locations of all drakes and pairs loafing on the peripheries of two islands in Miquelon Lake were recorded frequently. Meteorological conditions at the time of each count were noted.

Since the drakes of many species of waterfowl show little territorial behavior, the possibility that the



spacing of nests might be affected by interaction among nesting females was considered. In order to elucidate the existence and form of such interactions, a series of mounted skins were used in attempts to trigger aggressive or submissive behavior in nesting hens. Females of mallard (*Anas platyrhynchos*), gadwall (*A. strepera*), and lesser scaup, were used. All were mounted in an erect, alert posture. A bundle of green cloth, approximately the size of a duck, served as an amorphous, "control object" (Fig. 2). At the initiation of each trial, the hen was flushed from the nest and the dummy was positioned 1.5 m from the nest. The behavior of the hen as she returned to the nest was observed from an elevated blind. At the termination of each trial, the dummy was withdrawn by means of a light string attached to its base. This allowed observation of the hen's reaction to the movement. For each hen, the following four trials were planned; no dummy or object present, with the neutral object present, with a conspecific dummy, and with a dummy of a different species.

Rainfall, and daily maximum and minimum temperatures were recorded and appear in Appendix I.

Wherever possible, data were tested statistically with Chi-squared tests. Methods of application of tests are detailed in Appendix II. Nesting distributions were analyzed using Cox's (1967) random pairs method. Significance for all test statistics was at the 5% level.

Figure 2. Dummies used in experimental presentation to incubating hens in an attempt to elucidate the nature of behavioral interactions among nesting ducks.

- a) Lesser scaup
- b) Gadwall
- c) Mallard
- d) Bundle of cloth which served as an amorphous control object.











### III. DESCRIPTION OF STUDY AREA

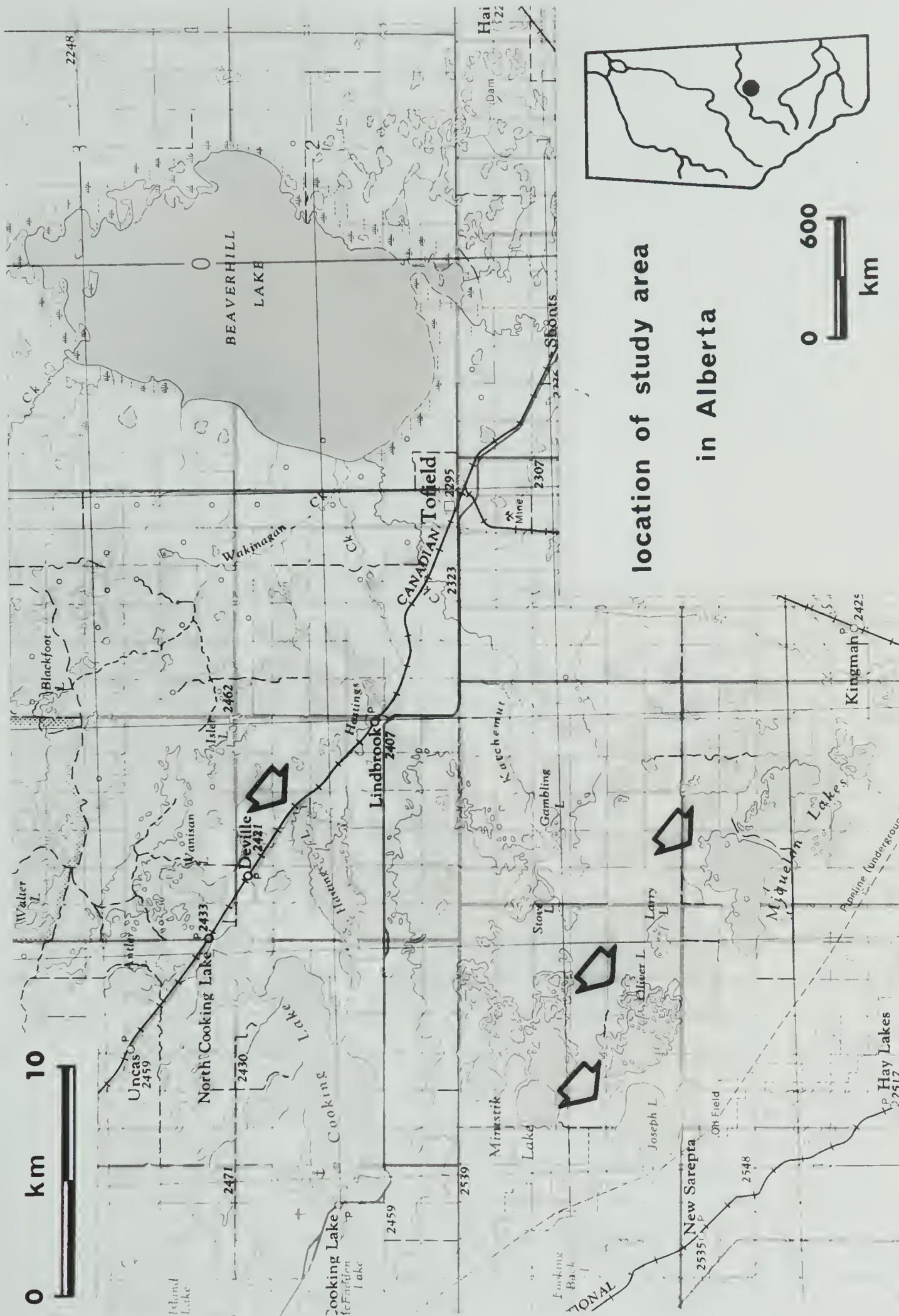
Miquelon, Hastings, Joseph, and Oliver Lakes are all located in forested knob-and-kettle terrain south-east of Edmonton (Fig. 3). This area is dominated by aspen poplar (*Populus tremuloides*) with isolated stands of white spruce (*Picea glauca*).

The physical and chemical characteristics of the four lakes studied are presented in Table 1.

Miquelon Lake (Fig. 4) was described by Kerekes (1965). It is relatively shallow (average depth 3 m in 1964) and alkaline. The water level has been dropping continually for the past 30 years, resulting in increased alkalinity (from 1383 ppm in 1964 to 1925 ppm in 1969) and in the emergence of new islands. Many rises which were previously islands are now forested hills along the shore. The present shoreline of Miquelon Lake is either sandy, or a mixture of mud and cobble-sized rocks. It is devoid of emergent vegetation. Only widgeon grass (*Ruppia occidentalis*) was found growing in the lake. The most noticeable aquatic invertebrate was an amphipod (*Hyallela azteca*). Sticklebacks (*Culaea inconstans*) were abundant until the winter of 1968-69 when there was an apparent total die-off.

Hastings Lake (Fig. 5) has a history of varying water levels, and is presently declining from a relatively high level. Several islands are rimmed with drowned willows (*Salix* spp.) and birch (*Betula* sp.), indicating that the

Figure 3. Map of the study area showing relative locations of Miquelon, Hastings, Joseph, and Oliver Lakes.



location of study area  
in Alberta



Table 1. Physical and chemical characteristics of Miquelon, Hastings, Joseph, and Oliver Lakes.

	LAKES			
	Miquelon	Hastings	Joseph	Oliver
Maximum length (Km) (1967)	5.6	6.5	4.5	3.8
Maximum width (Km) (1967)	3.4	2.2	3.2	2.5
Total number of islands (1967)	6	16	1	51
Number of islands studied	4	4	1	10
Total alkalinity (ppm) (1969)	1925	280	320	825
pH (1969)	9.7	8.7	9.8	9.5

Figure 4. Miquelon Lake, 1967. Locations of the islands studied are indicated.





Figure 5. Hastings Lake, 1967. Locations of the islands studied are indicated.







present water level is higher than in the past. Some islands that were separate in 1967 are now joined, indicating that the level is currently receding. Rooted aquatic plants were abundant and included *Najas flexilis*, widgeon grass, and several pondweeds (*Potamogeton* spp.). Aquatic invertebrates were abundant, with an amphipod (*Gammarus lacustris*) being the most obvious. The shores are mostly of the mud-cobble type and support extensive emergent stands of sedges (*Carex* spp.) cattail (*Typha latifolia*), bulrush (*Scirpus validus*), and reed grass (*Phragmites communis*).

Joseph Lake (Fig. 6) has a predominantly mud-cobble shoreline partly rimmed with emergent growths of bulrush and cattail. The water was extremely turbid.

Oliver Lake (Fig. 6) is situated in more uneven terrain, and has numerous islands and an irregular shoreline. The water level has been declining steadily for several years, alkalinity is moderately high, and mud-cobble shores are devoid of emergent vegetation. Widgeon grass was common, and amphipods were abundant. Oliver Lake is used by thousands of ducks during their flightless moulting period in mid-summer.

The islands studied were selected from those available on the basis of vegetation type, in an attempt to include a series of habitats representing levels of succession from exposed muddy or rocky conditions to aspen forest.

General categories of habitat established on the basis of the nature of the vegetation are presented in Table 2.

Figure 6. Joseph Lake (left) and Oliver Lake (right),  
1967 . Locations of islands studied are  
indicated.





Table 2. Characteristics of types of habitat defined on the basis of vegetation type, and the nature of the cover provided to nesting ducks. Species are listed in order of decreasing abundance.

Type	Description	Species
1	Pioneer - areas with sparse vegetation offering little or no cover.	<i>Hordeum jubatum</i> <i>Glyceria striata</i> <i>Chenopodium</i> spp. <i>Senecio congestus</i>
2	Emergent - typically emergent species offering high coverage.	<i>Scirpus validus</i> <i>Carex</i> spp.
3	Grass-Forb - heterogeneous areas dominated by low grasses, with scattered clumps of forbs and dead emergents. Low coverage.	<i>Hordeum jubatum</i> <i>Scirpus validus</i> <i>Carex</i> spp. <i>Cirsium arvense</i> <i>Sonchus arvensis</i>
4	Sparse forbs - offering low coverage.	<i>Cirsium arvense</i> <i>Sonchus arvensis</i>
5	Rank forbs - offering high coverage.	<i>Cirsium arvense</i> <i>Sonchus arvensis</i> <i>Urtica gracilis</i> <i>Artemisia absinthium</i> <i>Epilobium angustifolium</i>
6	Shrubs - high coverage.	<i>Ribes oxycanthoides</i> <i>Cornus stolonifera</i> <i>Shepherdia canadensis</i> <i>Salix</i> spp. <del><i>Rosa woodsii</i></del> <i>Rubus strigosus</i>
7	Forest - deciduous trees with a shrub understory.	<i>Populus tremuloides</i> <i>P. balsamifera</i> <i>Salix</i> spp. <i>Betula</i> spp. <i>Viburnum edule</i> <i>Amelanchier alnifolia</i> <i>Prunus pensylvanicus</i>
8	Reed - tall reed grass with high coverage.	<i>Phragmites communis</i>





The species involved in each category varied between locations.

Descriptive data for the 19 islands involved in this study are presented in Table 3. Patterns of vegetation on these islands are illustrated in Figures 7 to 15.



Table 3. Characteristics of the 19 islands studied in 1969.

Island	Length (m)	Width (m)	Area (ha)	Maximum elevation (m)	Types of Habitat (%) <sup>*</sup>							
					1	2	3	4	5	6	7	8
A	350	215	3.98	2	58	2	19	7	12	1	1	
B	340	233	4.72	2	71	1	6	4	17	1		
D	330	40	.11	0.5	100							
E	40	15	.04	0.5	100							
I	130	110	.89	1	31	1	50	16		2		
J	250	240	3.06	1.5	25	10	46		14		5	
K	220	200	2.32	2	14		43		9	12	22	
L	240	120	1.63	6	9		6	1		29	55	
M	230	40	.68	1.5	29	6	25	35	4	1		
N	110	70	.51	1	48	14	30		4	4		
O	100	50	.37	1	44	9	37			10		
P	130	45	.70	1	54	23	16			5		
Q	150	115	1.50	2	26		2		4	13	31	24
R	70	40	.33	1	82	7	11					
S	130	60	.54	1	79	6	13			2		
T	50	30	.10	0.5	89			11				
U	180	150	.42	1	74	4	18			2	2	2
V	120	50	.33	2.5	53	7	33			7		
W	125	110	.91	1.5	26		24			14	24	12

- \*

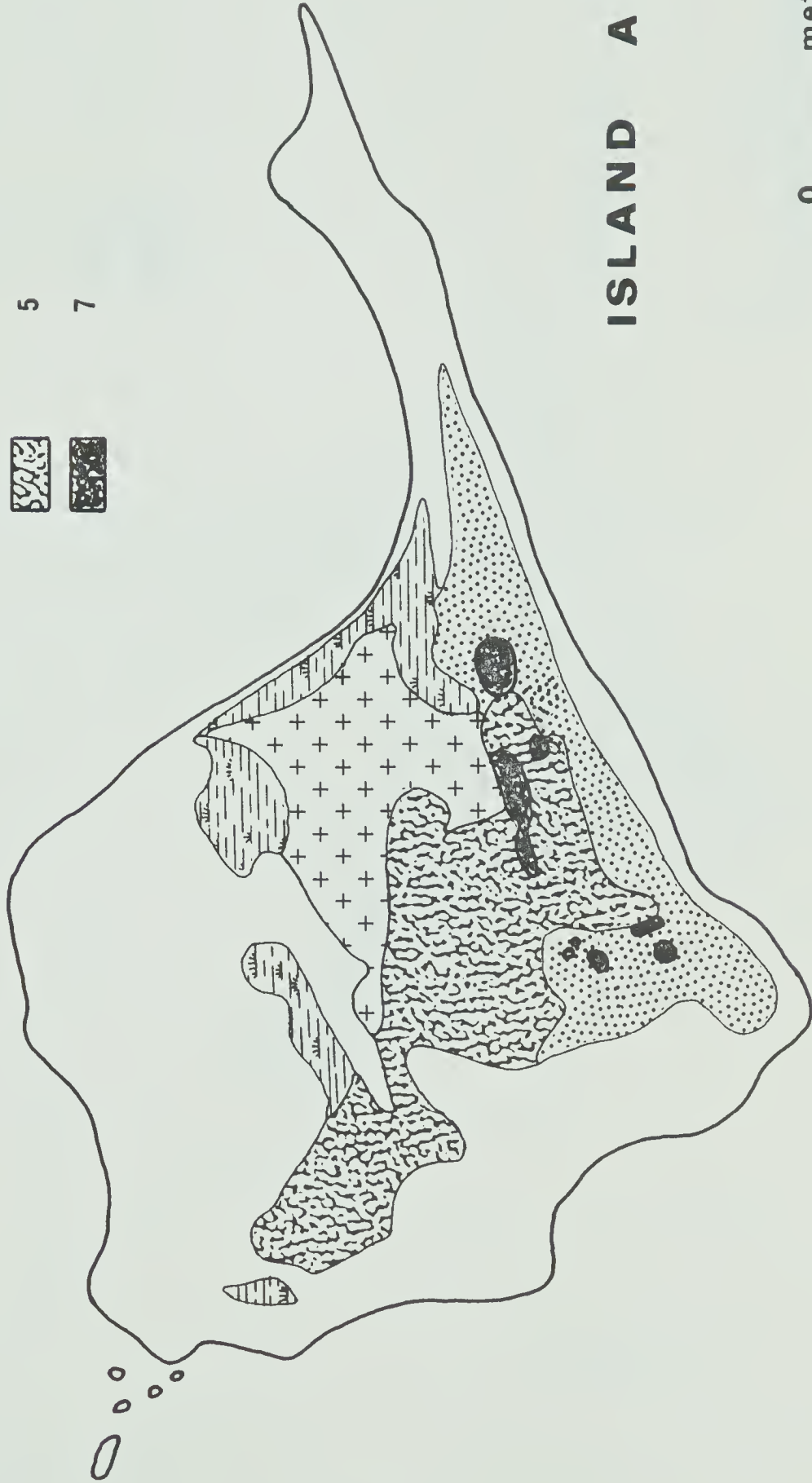
1 - Pioneer
- 2 - Emergent
- 3 - Grass-forb
- 4 - Sparse forbs
- 5 - Rank forbs
- 6 - Shrubs
- 7 - Forest
- 8 - Reed

Figure 7. Vegetation patterns on Island A in 1968.  
Miquelon Lake, Alberta.



habitat type

- |  |   |
|--|---|
|  | 1 |
|  | 2 |
|  | 3 |
|  | 4 |
|  | 5 |
|  | 7 |



ISLAND A (1968)



Figure 8. Vegetation patterns on Islands A and E in  
1969, Miquelon Lake, Alberta.



**ISLAND E**

habitat type



1



2



3



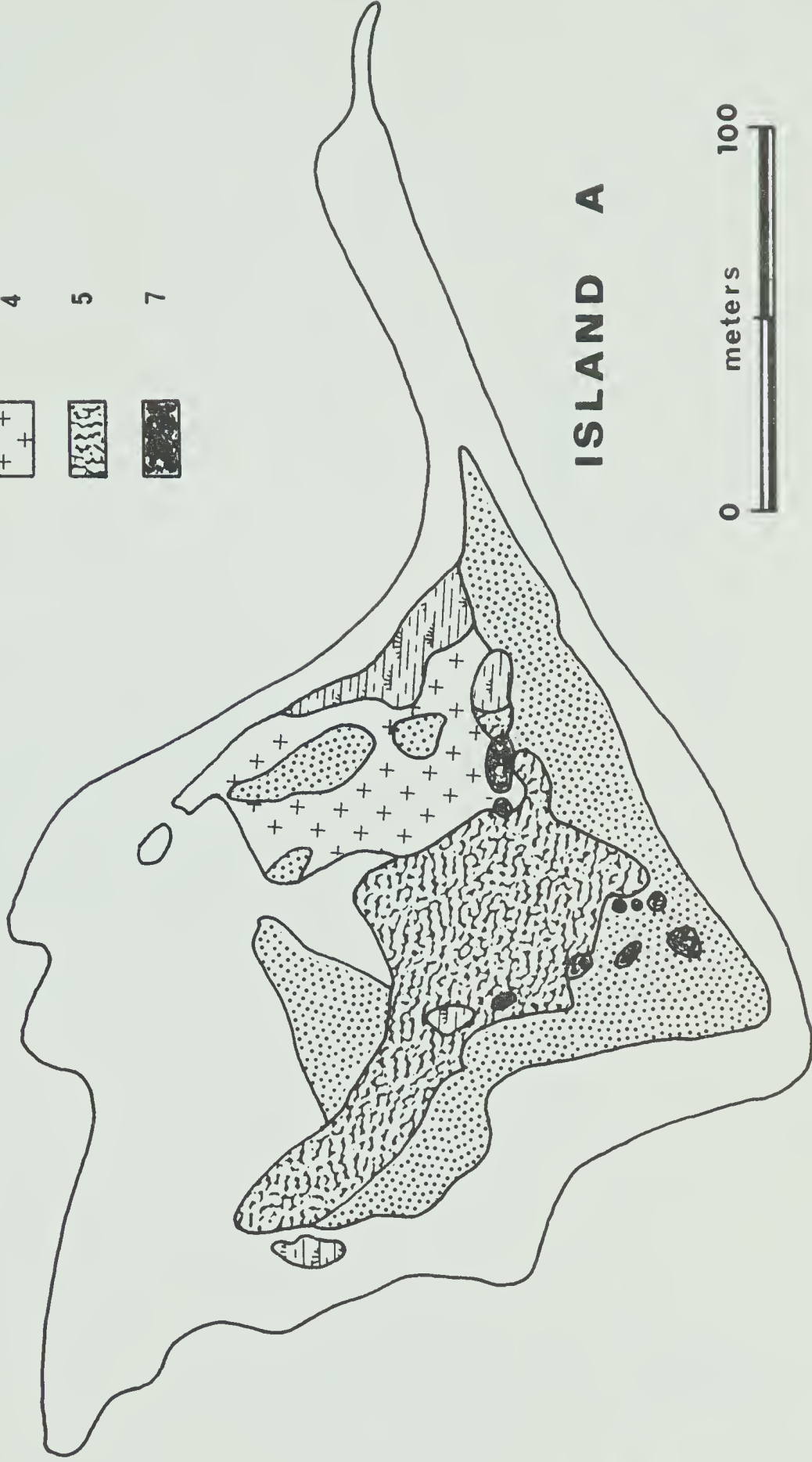
4



5



7



**ISLAND A**

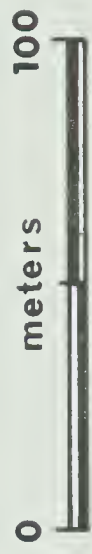
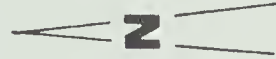
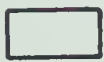


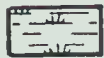
Figure 9. Vegetation patterns on Island B in 1968.  
Miquelon Lake, Alberta.



habitat type



1



2



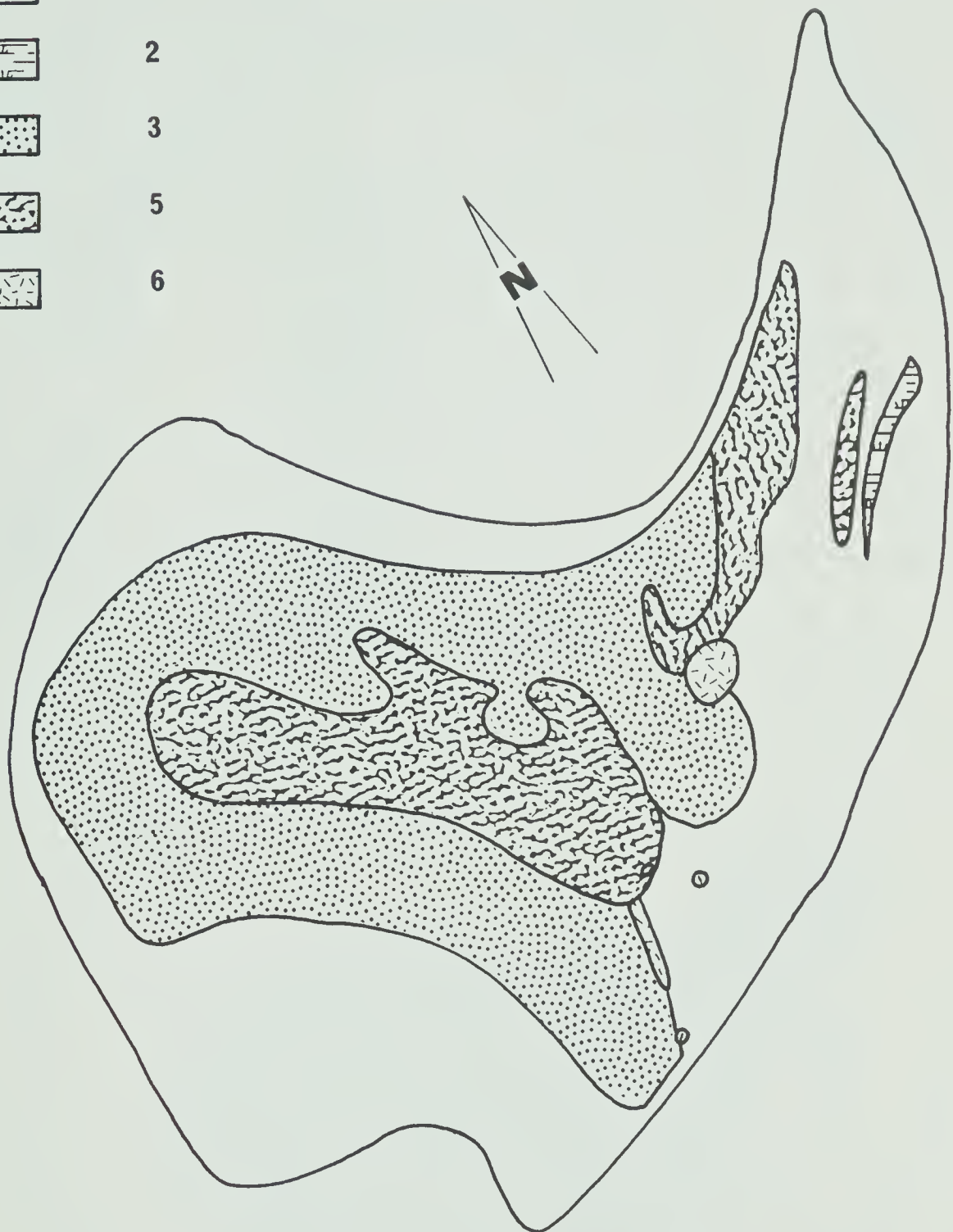
3



5



6



**ISLAND B (1968)**



Figure 10. Vegetation patterns on Islands B and D in  
1969. Miquelon Lake, Alberta.

**ISLAND D**



habitat type



1



2



3



4



5



6

**ISLAND B**



Figure 11. Vegetation patterns on Islands I and J in  
1969. Hastings Lake, Alberta.

habitat type

1

2

3

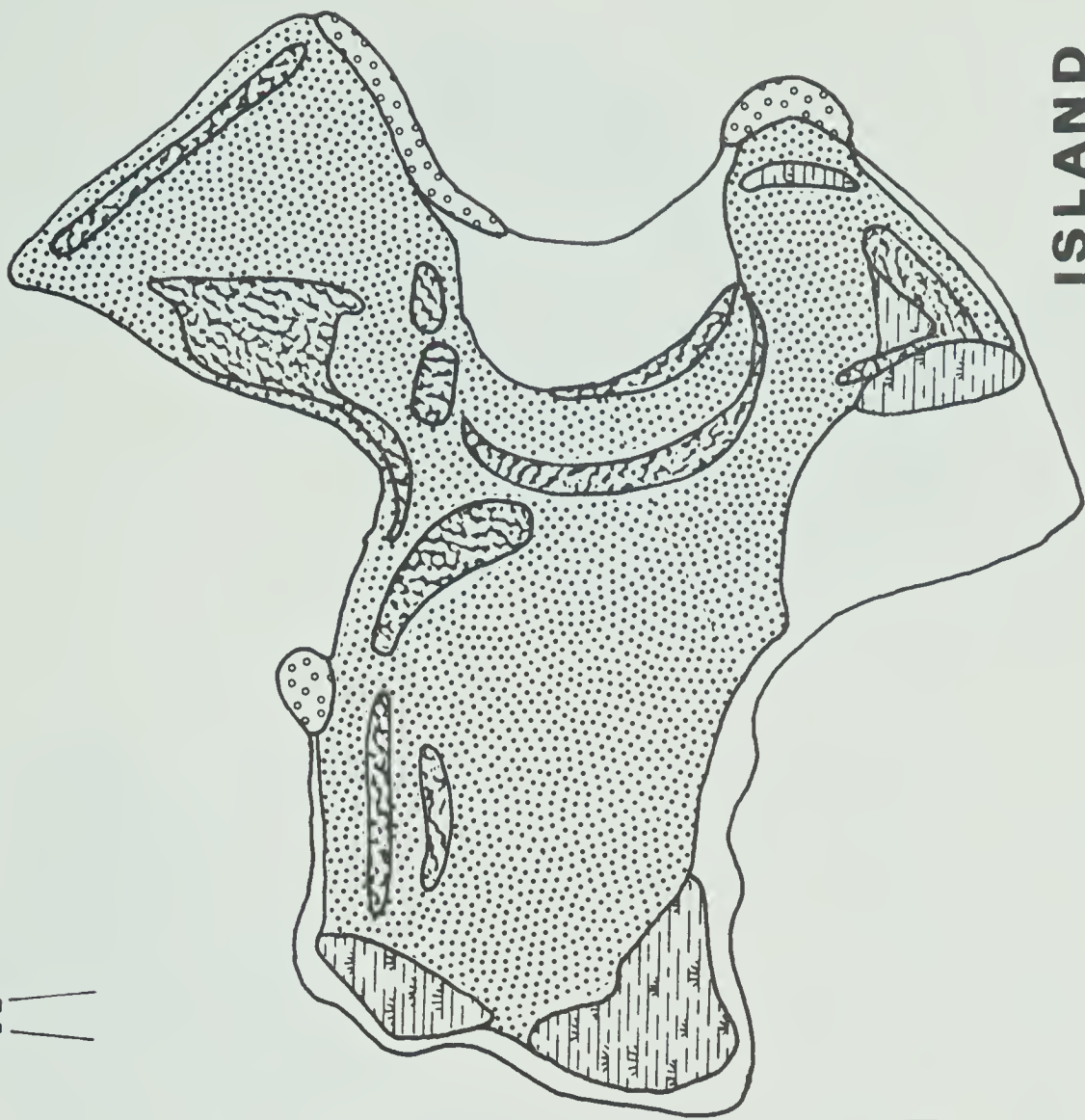
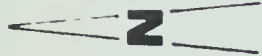
4

5

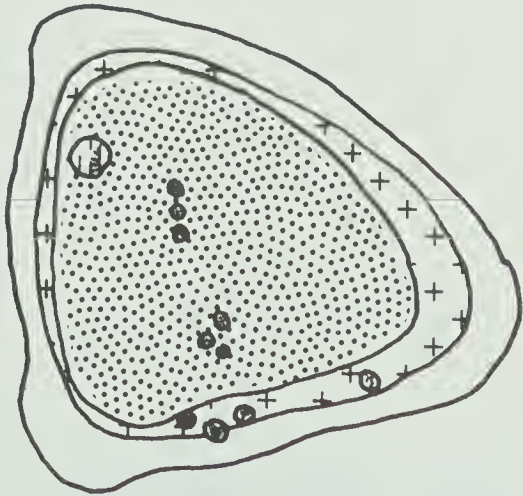
6

7

8



ISLAND J



ISLAND I

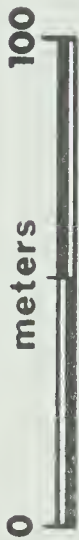
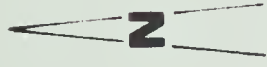


Figure 12. Vegetation patterns on Islands K and L in  
1969. Hastings Lake, Alberta.

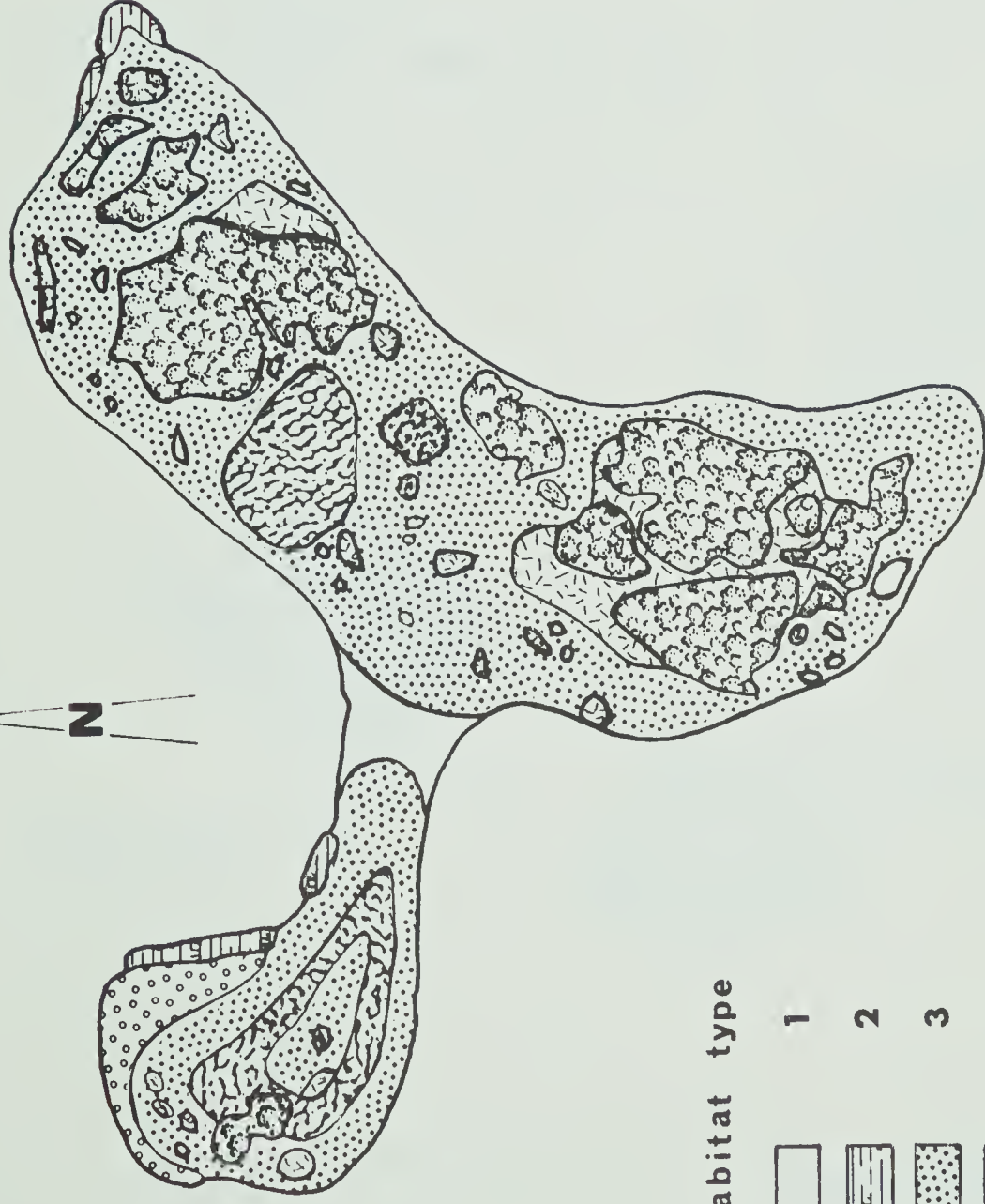




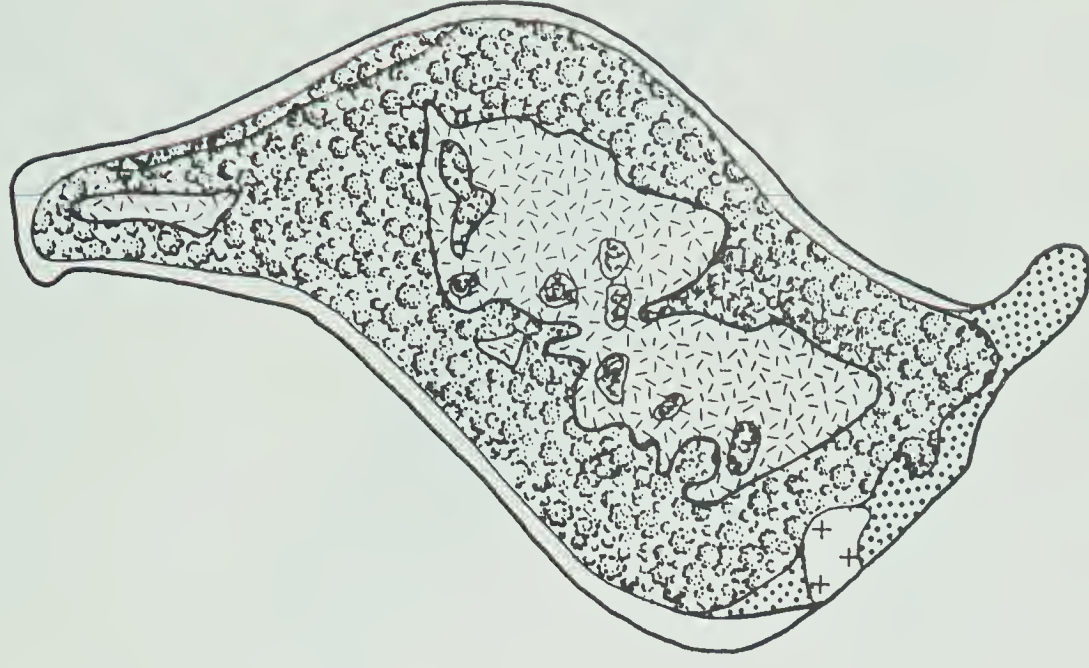
habitat type



1 2 3 4 5 6 7 8



ISLAND K

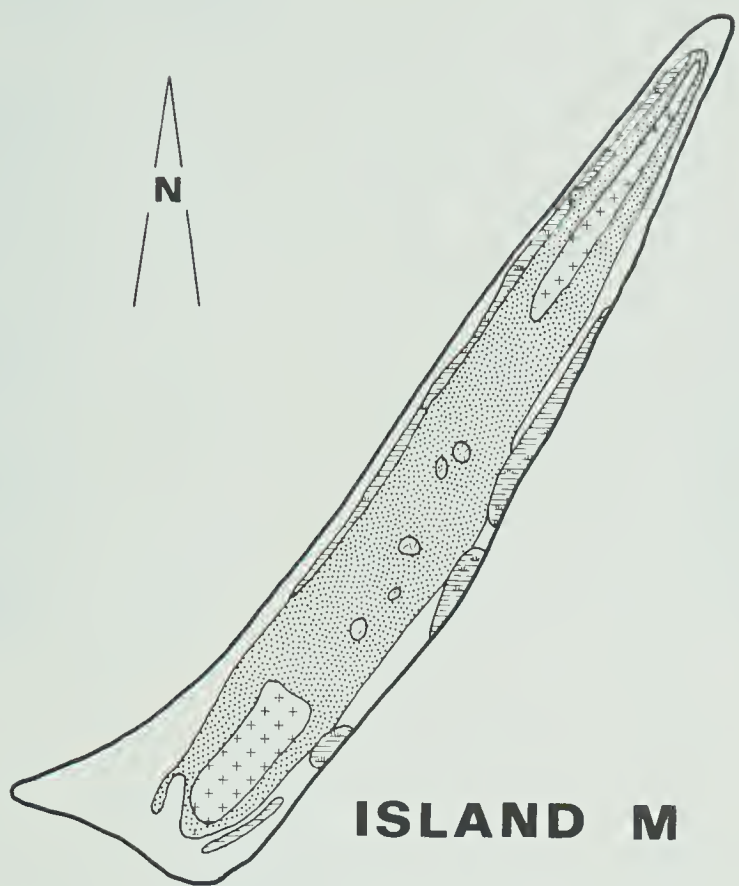


ISLAND L



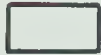
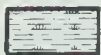







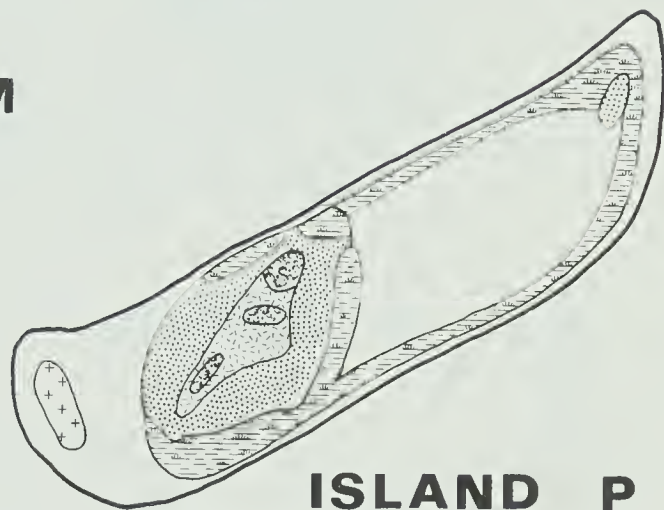
Figure 13. Vegetation patterns on Islands M, N, O, and P in 1969. Island M is in Joseph Lake, others are in Oliver Lake, Alberta.



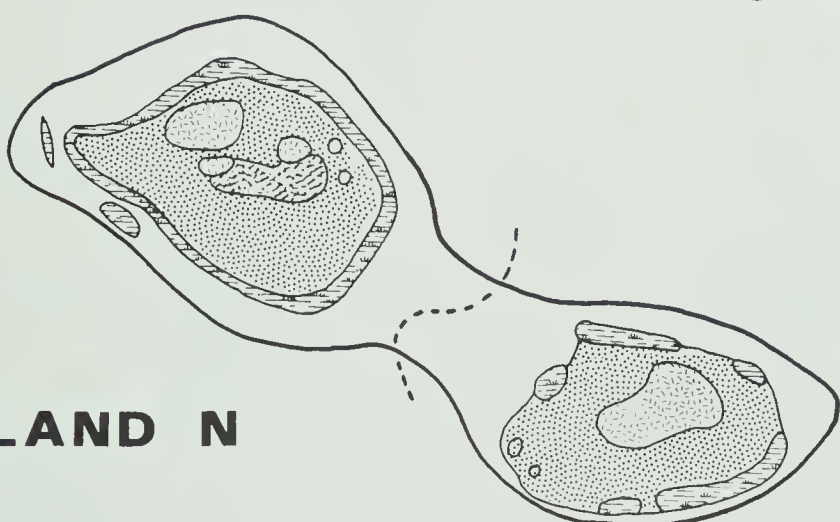
**ISLAND M**

**habitat type**

- |   |          |
|---|----------|
|  | <b>1</b> |
|  | <b>2</b> |
|  | <b>3</b> |
|  | <b>4</b> |
|  | <b>5</b> |
|  | <b>6</b> |
|  | <b>7</b> |



**ISLAND P**



**ISLAND N**

**ISLAND O**



Figure 14. Vegetation patterns on Islands Q, R, S. and  
T in 1969. Oliver Lake, Alberta.

habitat type



1



2



3



4



5



6



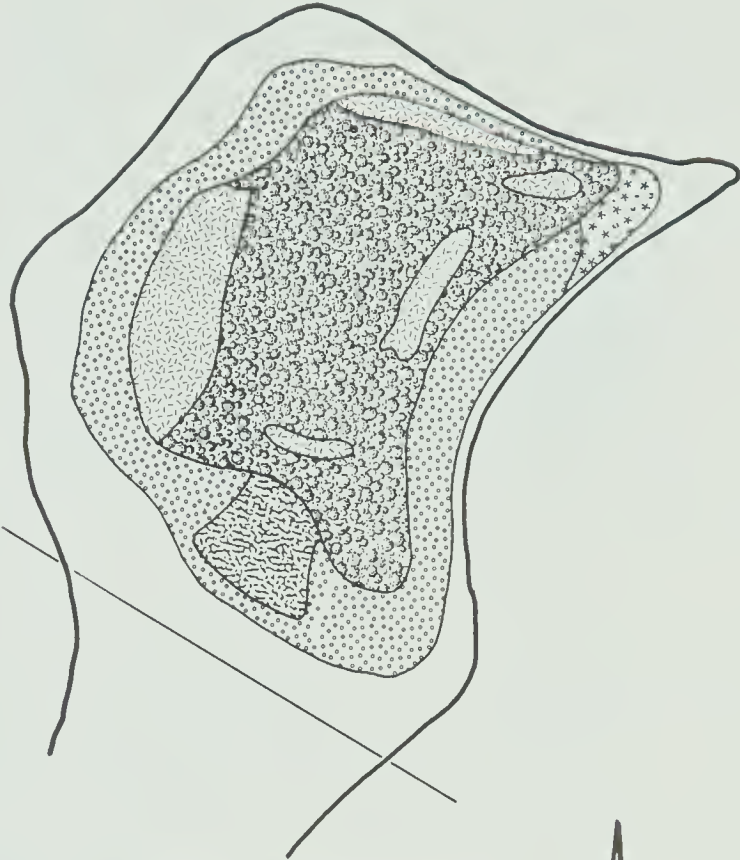
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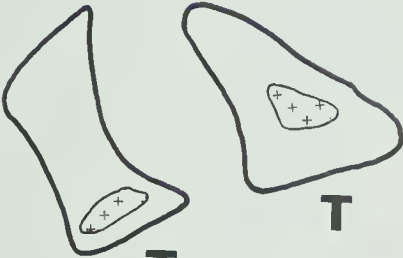
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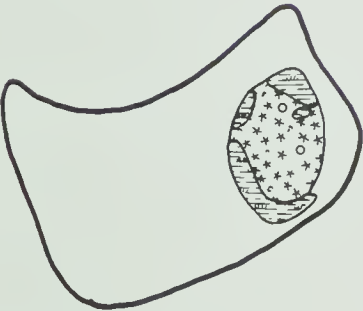
water



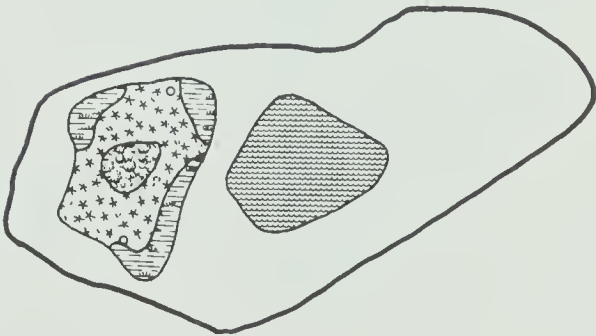
ISLAND Q



ISLANDS



ISLAND R



ISLAND S



Figure 15. Vegetation patterns on Islands U, V, and W in 1969. Oliver Lake, Alberta.

habitat type



1



2



3



6



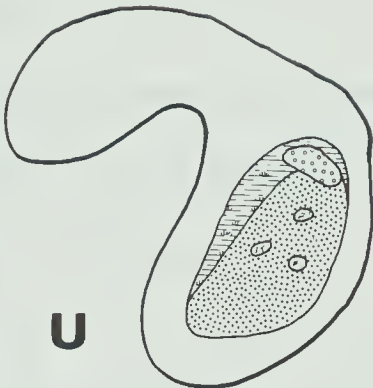
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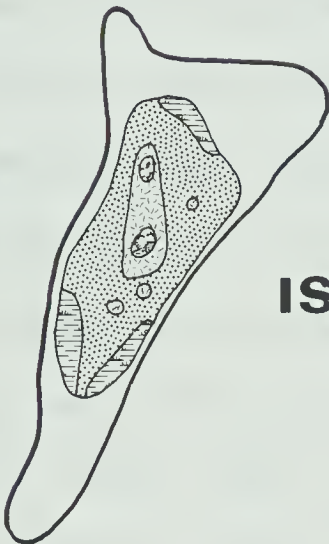
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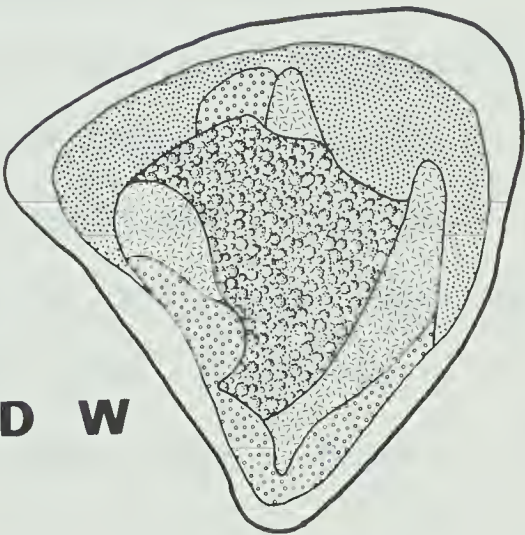
ISLAND U



ISLAND V



ISLAND W







## IV. RESULTS AND DISCUSSION

## IV-1 NUMBERS OF NESTS

During the two year study, a total of 461 duck and goose nests were examined. Of these, 243 were found in 1969.

Numbers of nests of different waterfowl species found on islands in Miquelon Lake from 1964 to 1969 appear in Table 4, and those on islands in other lakes studied in 1968 and 1969 in Table 5. In both years of this study, and in all areas studied, the lesser scaup was the most abundant nesting anatid, followed by gadwall and mallard. Canada geese (*Branta canadensis*), white-winged scoters (*Melanitta fusca*), pintails (*Anas acuta*), redheads (*Aythya americana*), canvasbacks, blue-winged teal (*Anas carolinensis*), baldpate (*Mareca americana*), and shovelers nested in low numbers. With the exception of white-winged scoters, which were abundant on the lakes but rarely found nesting on the islands, the numbers of nests of the different species appeared to reflect their relative abundance on the lakes.

It is unlikely that many nests were established on the islands and remained undiscovered. Searches were frequent enough to guarantee at least two visits during laying and incubation of every nest. Twenty-nine percent of all lesser scaup and gadwall nests located in 1969 (154) were discovered before laying was complete — they were found



Table 4. Numbers of anatid nests on Islands A and B of Miquelon Lake for the years 1964 to 1969. (a) Vermeer 1967 (b) Dwernychuk 1968

	Island A										Island B				
	1964 <sup>a</sup>	1965 <sup>a</sup>	1966 <sup>b</sup>	1967 <sup>b</sup>	1968	1969	1964 <sup>a</sup>	1965 <sup>a</sup>	1966 <sup>b</sup>	1967 <sup>b</sup>	1968	1969			
lesser scaup	41	42	20	10	36	28	26	28	21	14	12	18			
gadwall	26	15	16	11	23	13	3	10	2	6	6	13			
mallard	9	3	2	5	9	3	3	3	3	2	3	5			
pintail	2	1	2	3	4	0	4	6	1	5	2	7			
shoveler	0	0	0	0	3	0	0	0	0	0	0	0			
white-winger scoter	9	1	6	3	1	3	2	7	1	4	1	0			
baldpate	3	1	1	1	1	2	2	1	1	0	0	0			
redhead	0	0	0	0	0	0	0	0	1	0	0	2			
canvasback	0	0	0	0	0	0	0	0	0	0	0	1			
Canada goose	0	0	0	0	1	2	1	1	-	-	1	4			
Total	90	63	47	33	78	51	41	56	30	31	25	50			



Table 5. Numbers of anatid nests on the islands of Hastings, Joseph, and Oliver Lakes in 1968 and 1969. Numbers in parentheses are for 1968.

	Hastings L.										Oliver Lake										Joseph L.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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without the aid of a flushing hen betraying their location. Over 80% of nests were found during the first search conducted while the duck was incubating.

High densities of duck nests in island situations are well known (Bent 1925, Duebbert 1966, Vermeer 1968). Nesting behavior and hatching success appear to be normal except where densities are extreme. Hammond and Mann (1956) state that social interaction is a factor limiting the density at which ducks can nest. Only on Island S in 1968 was there any evidence, in this study, that nesting behavior was altered as a result of social interaction. Because of this abnormal situation, nests on Island S will be discussed separately.





## IV-2. THE PROCESS OF NEST-SITE SELECTION

Weller (1959) discusses nesting behavior of Anatidae and states that selection of the nest site is by the female, often accompanied by the drake. In *Anas* the drake always accompanies the duck but in *Aythya* he seldom enters the vegetation in which the nest will be established.

In some species, preliminary search for suitable nesting cover is done by the pair during long, seemingly aimless, flights in morning or evening (Bennett 1938, Gehrman 1951).

Closer examination of the nesting terrain is done on foot. Drake blue-winged teal follow the duck closely (Bennett 1938). In several other species the drake waits nearby, in a clearing, or at the water's edge, while the female explores the nesting cover (Gehrman 1951, Mendall 1958, Duebbert 1966).

There appears to be no evidence that the drake plays any role in nest-site selection in any of the North American Anatini or Aythyini.

The construction of the nest in Anatidae accompanies, rather than precedes laying (Sowls 1955). The initial stage is usually the construction of a shallow depression, or "scrape". This is done by the duck, using its feet. Redheads begin scrapes 2 to 7 days prior to the commencement of laying (Low 1945). Hammond (in Sowls 1955) says that mallards construct scrapes up to 6 days before laying



while pintails and gadwalls usually begin 4 days prior to laying. The first egg is generally layed in the unlined scrape and is often soiled by the subsequent activities of the duck. Duebbert (1966) made several scrapes in an area in which gadwalls were nesting in high concentrations, and found one of them to contain five eggs on a subsequent examination. From this he concluded that the presence of the nest bowl may act as a stimulus for laying. During the course of searches for nests in this study, in the order of 100 fresh scrapes were discovered. In no instance was one of these subsequently developed into a nest. Several scrapes found with only the first egg were subsequently developed. Bennett (1938) and Glover (1956) attributed similar findings to the readiness with which the duck will abandon a site before laying. It appears that ducks initiate and abandon several scrapes before laying commences (Hochbaum 1944). I have found no evidence that a duck ever returns to a scrape made during the pre-laying period. Glover (1956) states that this occasionally occurs in blue-winged teal.

It appears that the selection of a potential nesting site, and the creation of a scrape, may be repeated on each daily visit to the nesting habitat. The construction of scrapes may be a necessary stimulus for ovulation as is nest-building in the domestic canary (*Serinus canarius*) (Hinde 1966). If so, the site of the definitive nest may be nothing more than the site selected on the day that the



first egg is laid. It may not be superior to the sites selected earlier.

Such a sequence of events would indicate that potential nest sites are more abundant than suggested by the number of nests actually established in the area. It would be valuable to examine fresh scrapes to determine if they differ in any way from the sites finally used as nest locations. This was not done in this study.

Svårdson (1949) stated that purely optical stimuli are involved in habitat selection by birds. Emlen (1955) presented the concept of selection based on a "perception" of the sum of all factors existing at the site. Selection for a complex of factors sensed as an entity, is likely, rather than for a series of individual factors. Hildén (1965) termed this the principle of summation of heterogeneous stimuli.

The term "selection", used in subsequent discussion, designates the process which directs nesting ducks to use habitat out of proportion to its availability. The process may or may not involve the actual weighing of alternatives by nesting birds. The term "preference" refers to the resulting disproportion between the availability of a condition, and its use by ducks. Throughout most of the following discussion it is assumed that ducks may freely select from all sites on the island, without influence from previously established birds.





## IV-3. USE OF DIFFERENT TYPES OF HABITAT BY NESTING DUCKS

The general nature of the habitat is likely a basic consideration as ducks select a nest site. The eight types of habitat defined in Table 2 represent a broad classification of the diversified habitats that existed on the islands studied.

Data on the availability of each of these types, and their relative utilization by nesting ducks appear in Table 6. Each species of duck, and the combination of all species show a distribution that differs significantly from that expected on the basis of availability of habitat.

Pioneer vegetation, Sparse Forbs, Forest, and Reed grass appeared to be avoided by all species. Lesser scaup showed greater tolerance of the open Pioneer and Sparse forb types. Mallards used forested sites more readily than gadwall or scaup. Mallards are known to utilize a broad range of nesting habitats, and to use forested areas more readily than other species (Bent 1925). Pure stands of tall reed grass were not used as nesting cover. Hochbaum (1944) and Sowls (1955) also reported this.

Of the preferred habitats, rank forbs were selected most strongly. Gadwall showed the greatest preference, followed by lesser scaup. Mallards seldom have the opportunity to use this habitat because they nest early, before forb growth is well developed. Late nests of this species were not sufficiently abundant to allow evaluation



Table 6. Numbers of duck nests established in each of eight types of habitat (defined in Table 2), and relative availability of each type. Data for 1968 and 1969 are pooled.

	Percent of total <sup>a</sup>								
Type of habitat	1	2	3	4	5	6	7	8	Total
Utilization (no. of nests)									
lesser scaup	15	11	30	4	24	12	4	0	152
gadwall	4	8	23	1	42	20	3	0	79
mallard	7	37	17	2	13	19	6	0	54
all species <sup>b</sup>	12	15	24	2	27	16	4	0	323
Availability of habitat (ha)									
	48	4	19	4	11	4	8	2	30.8

- a    1 - Pioneer  
      2 - Emergent  
      3 - Grass-forb  
      4 - Sparse forb  
      5 - Rank forb  
      6 - Shrub  
      7 - Forest  
      8 - Reed

- b    All duck nests for which habitat type was recorded.



of selection for forbs when they were well developed.

Shrubs were strongly selected as nesting cover. Gadwall and mallard showed strongest preference. Shrubs, especially gooseberry, are in leaf early in May and provide excellent cover for early nesting mallards.

Green bulrush and sedge were preferred by mallards. Where these typically emergent species are found on dry land there is an accumulation of residual material that provides well concealed nesting sites even in early spring. Gadwall appeared to strongly avoid this type of growth, possibly as a result of their reported preference for dry, upland sites (Bent 1925, Gates 1962).

The Grass-Forb complex was selected by lesser scaup. The heterogeneity of this habitat may be an attracting factor.

These results indicate that ducks do indeed select the general nature of the habitat, and that the species differ in their preferences.

The series from Pioneer vegetation to Forest approximates the progression from the shore to the center of many islands. Most of the islands were formed during the last 40 years due to water level fluctuations resulting in a net decrease. The level of Miquelon Lake has dropped about 5 m since 1930 (F. Erickson, pers. comm.). The succession of plant communities on the islands was likely influenced by many factors including: the nature of the substrate, the rate of emergence, and the chance arrival of specific



disseminules. During the winter of 1967-68 two new islands (D and E) emerged in Miquelon Lake, Both were colonized in the first year by isolated plants of goosefoot (*Chenopodium salinum*) and manna grass (*Glyceria striata*). In 1969, goosefoot dominated on the rocky substrate of E while manna grass dominated on the mud-flats of D. The difference in dominants probably correlates with the different types of substrate. These two species appeared to be the principal pioneer plants over the entire study area. Several islands were partly rimmed with verdant bulrush or sedge, separated from the water by a mud beach. These probably originated as emergent stands during a period of relatively stable water levels.

Immediately interior to these pioneer types of vegetation there was usually an area characterized by a complex of low grasses, patches of forbs, and some dead bulrush. In the event of continually lowering water levels, it is likely that this Grass-Forb complex would be invaded by shrubs, and eventually by aspen poplar or other trees. This is suggested by the frequent occurrence of central clump of shrubs and small trees on the islands.

Apparently, under certain conditions, areas dominated by grasses may be invaded by dense forb growth. On Islands A and B the fertilizing effect of droppings accumulated from long-term colonization by gulls has resulted in a lush, forb-dominated disclimax. Dense forb growth also occurred in moist, low-lying areas of other islands.



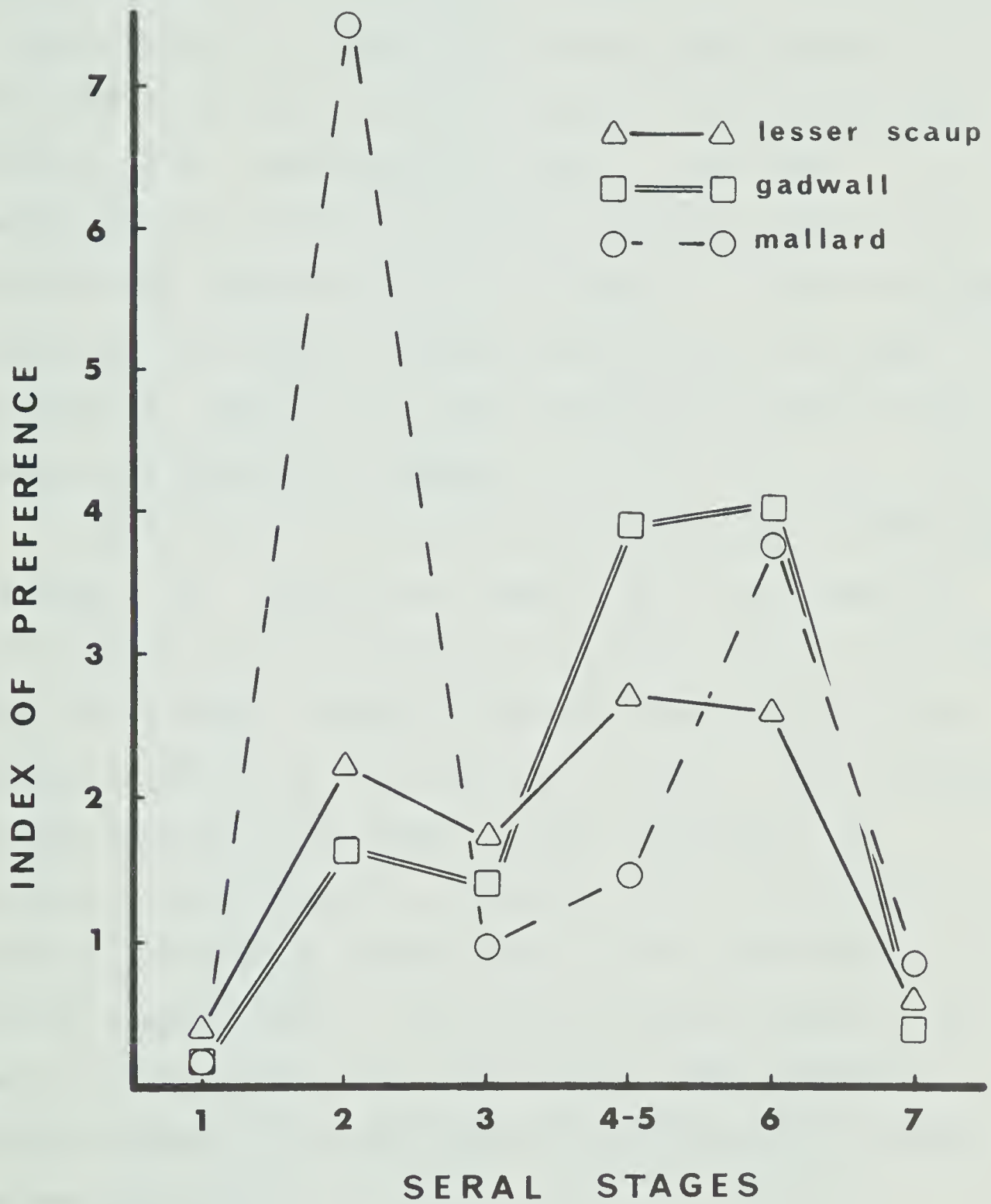


In the event of progressively declining water levels, it is possible that any habitat in the sequence between Pioneer and Forest (Table 2) would become invaded by vegetation typical of one of the higher numbered types. Data that would allow prediction of successional changes are not available, but the order of arrangement in Table 2 places each type in the relative position in which it would likely occur during succession. Vegetation patterns on the islands suggest that the most likely sere would be, Pioneer - Grass-Forb - Shrub - Forest.

Changes from one stage to another would result in a change in the species composition of the ducks nesting on the area (Fig. 16). The presence of emergent species would allow early use by mallards. The more common progression from Pioneer to Grass-Forb would result in only a slight increase in all species. In areas where there was a Rank Forb community gadwall and scaup would occur in large numbers. Invasion of Grass-Forb areas by shrubs would encourage nesting of gadwall and mallard. The encroachment of trees on the area would restrict the nesting activities of all three species.

It appears that the species composition of the ducks nesting on an island is influenced by successional changes that have occurred there. The exact sequence of these changes depends on a complex of historical and environmental factors.

Figure 16. Indices of preference of three species  
of ducks for six types of habitat.





## IV-4. PROPERTIES OF VEGETATION AROUND NESTS

IV-4a. Selection for species and physiognomy of vegetation

The availability of taxonomic groups of plants on island A in 1969, and their relative utilization as nesting cover by ducks is illustrated in Figure 17. In this figure, a plant species is considered to have been present if it occurred in at least 10 of the  $100 \text{ dm}^2$  which made up an area of  $1 \text{ m}^2$  centered on the nest. With the exception of sowthistle (*Sonchus arvensis*), there is no significant disproportion of utilization. Both the lesser scaup and all species combined significantly avoided sowthistle. There were trends indicating selection for sedges and gooseberry (*Ribes*).

Similar data for the entire study area in 1969 appear in Figure 18. These allow comparison of the degree of utilization of plant species as nesting cover by the three species of ducks. Gadwall differed significantly from lesser scaup in the distribution of nests. The difference arises mostly in the sedge, bulrush (*Scirpus*), and miscellaneous categories, probably reflecting general habitat preferences rather than species preferences. Of the 28 gadwall nests in the miscellaneous category, 18 were located under woody shrubs other than gooseberry - further exemplifying the gadwall's preference for shrubs as nesting cover.

The fact that these data fail to show any strong

Figure 17. Percent of nests and randomly selected points at which each of ten taxonomic groupings of plants occurred on Island A in 1969.



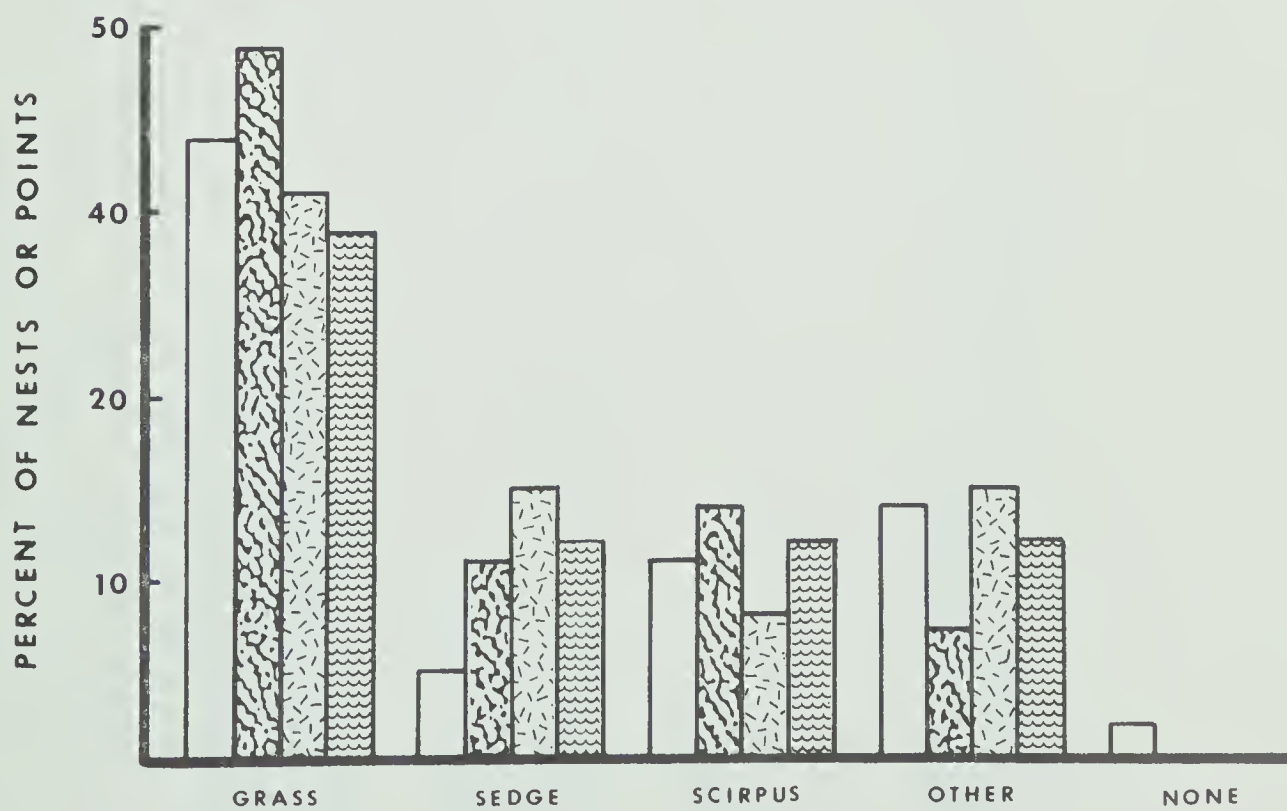
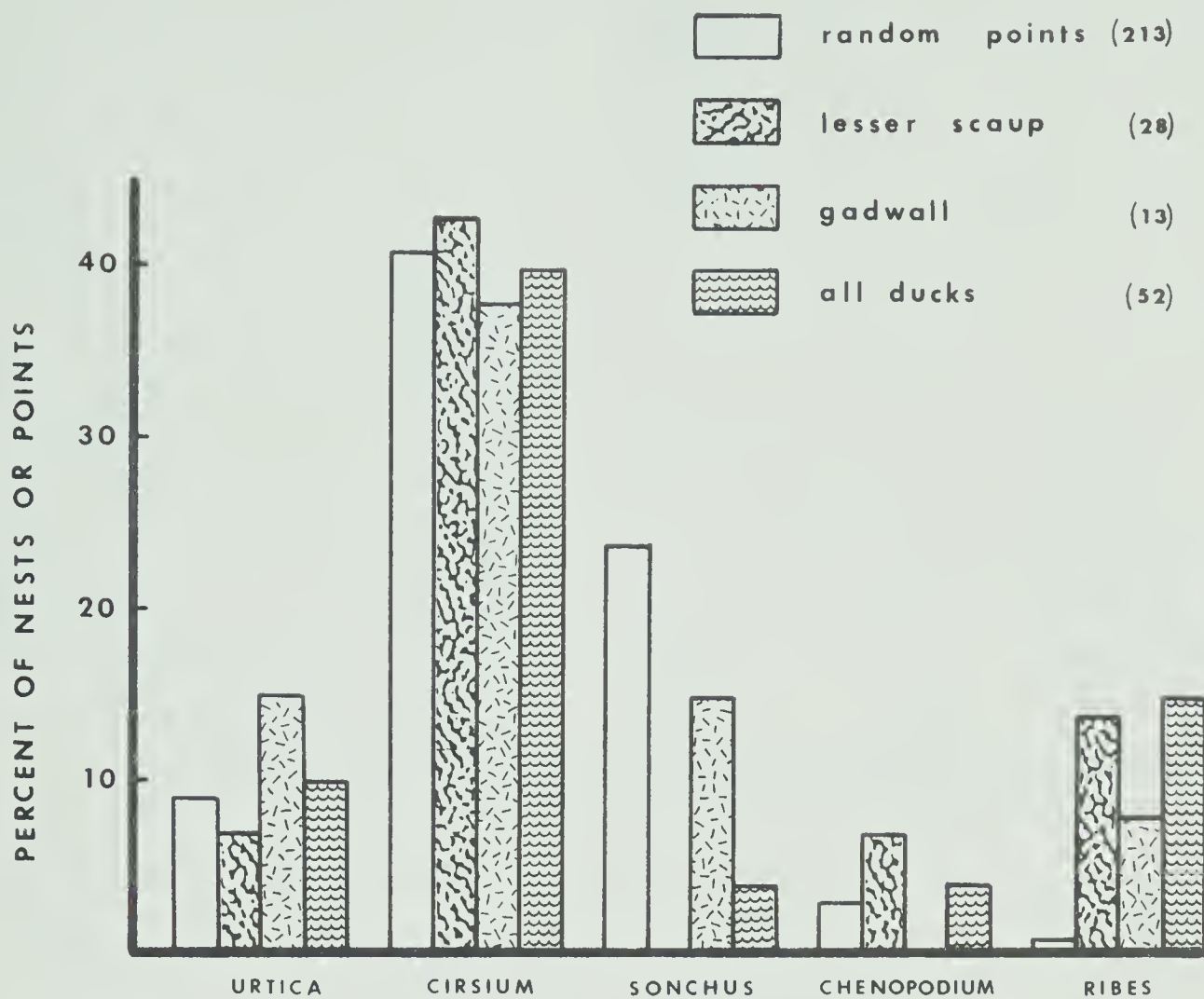
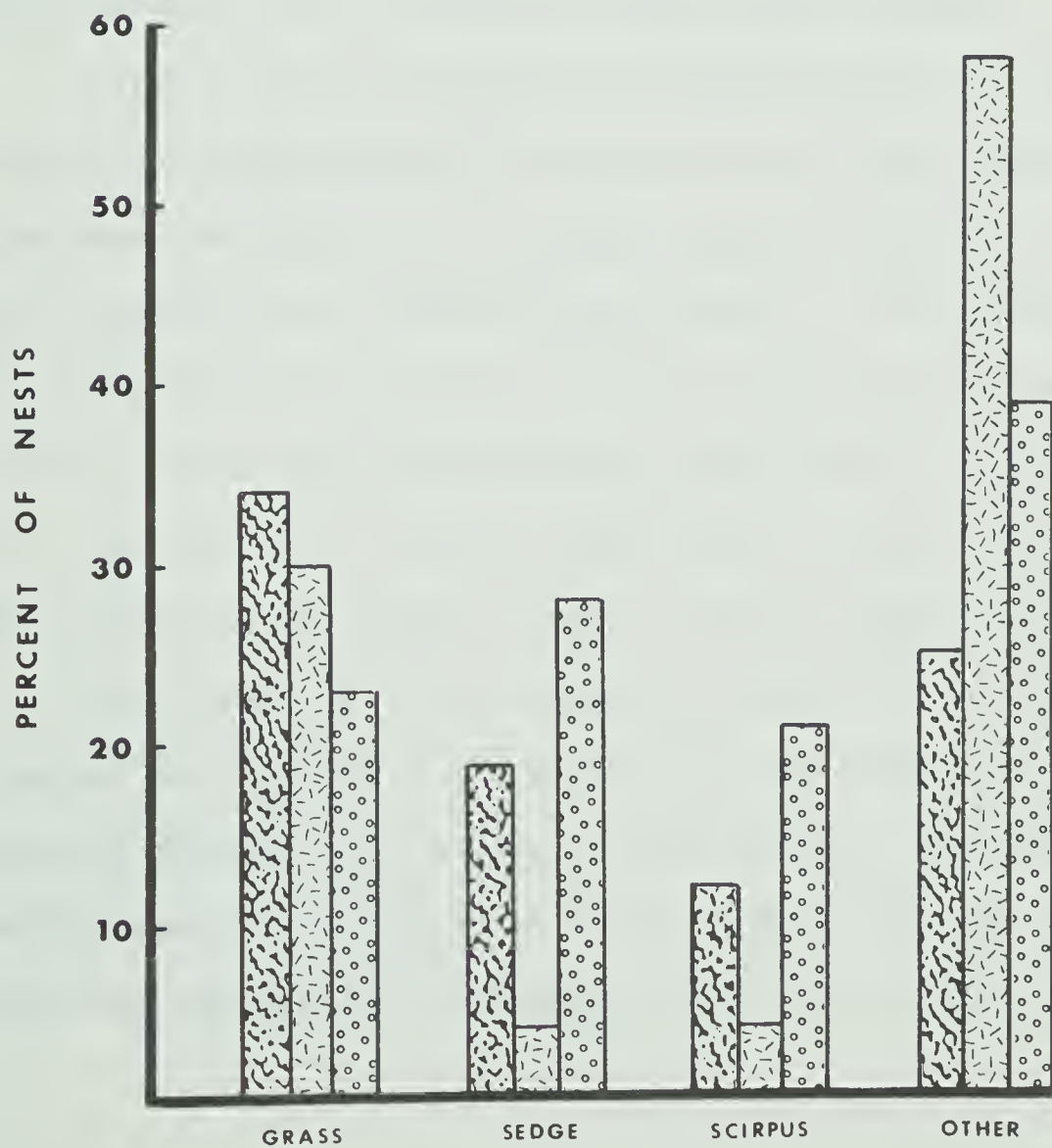
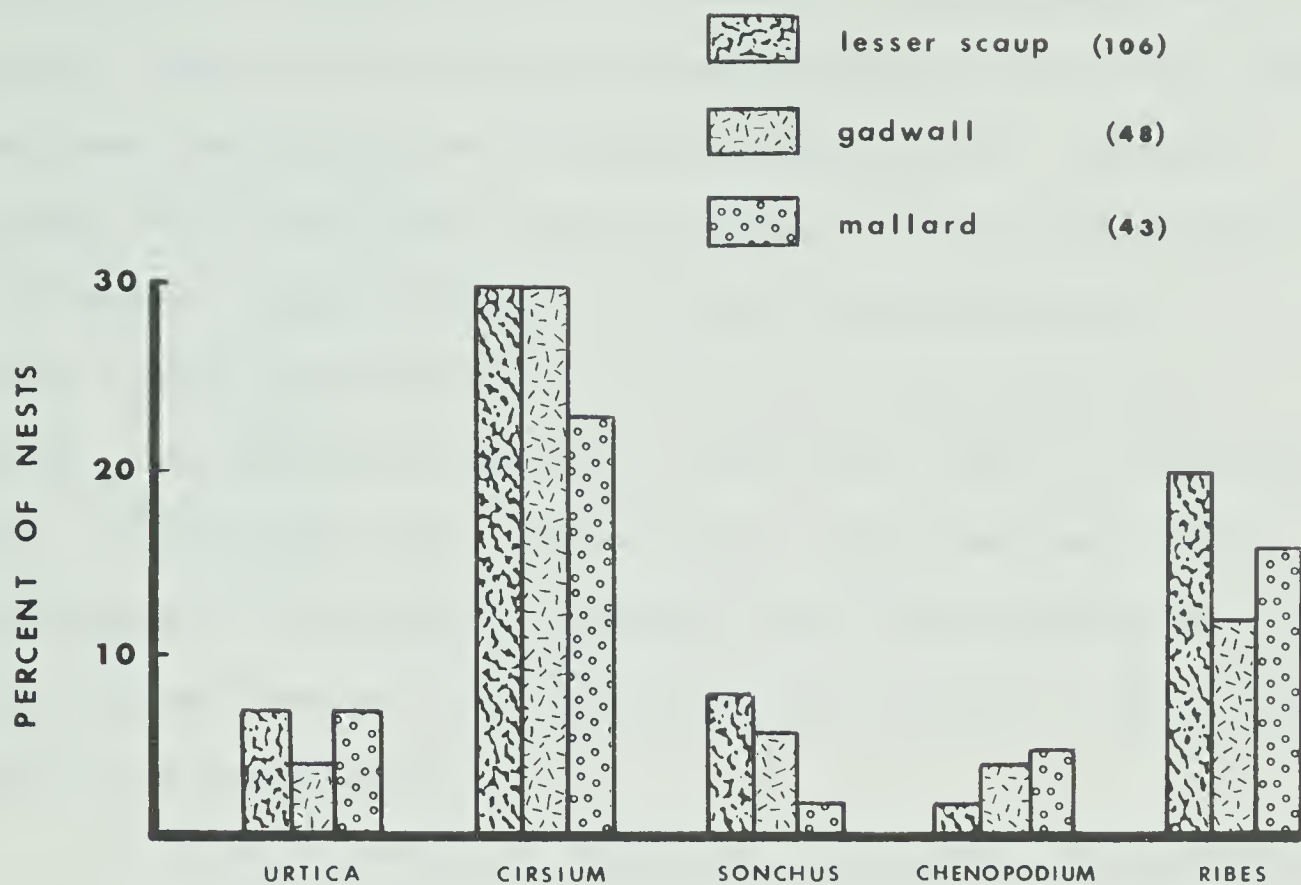


Figure 18. Percent of nests of three species of ducks at which each of nine taxonomic groupings of plants occurred, on the entire 1969 study area.





preference or selection for taxonomic plant groups tends to cast doubt on the value of nesting studies in which this has been the criterion of habitat description. Mendall (1958) felt that plant species was of little significance, and Gehrman (1951) failed to detect any preference for plant species association in a study of nesting lesser scaup. In work with warblers, MacArthur (1964) concluded that, having described the habitat in physiognomic terms, knowledge of the species composition of the vegetation did not improve the ability to predict the number of pairs that would use the habitat.

In light of this, it would seem advisable to approach the analysis of nesting habit from a physiognomic point of view rather than a species association aspect.

Knight (1965) considered growth form in an attempt to interpret preference of nesting ducks for prickly lettuce (*Lactuca serriola*) over summer cypress (*Kochia scoparia*), and lambsquarter (*Chenopodium album*). He considered that the pyramidal form of the prickly lettuce provided good cover at the level of the nest, yet still allowed the duck to flush easily. On the other hand, broad tops of cypress and lambsquarter would hamper a rapid departure.

The common plant species on the study area were grouped on the basis of type of cover that they provide for nesting ducks. The general physiognomic forms and representative species are presented in Figure 19 and Table 7. With the exception of Type F, there was little difficulty

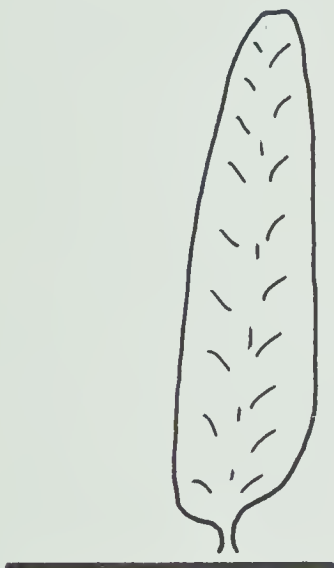
Figure 19. Illustration of six physiognomic forms  
of plants occurring on the islands of the  
study area.



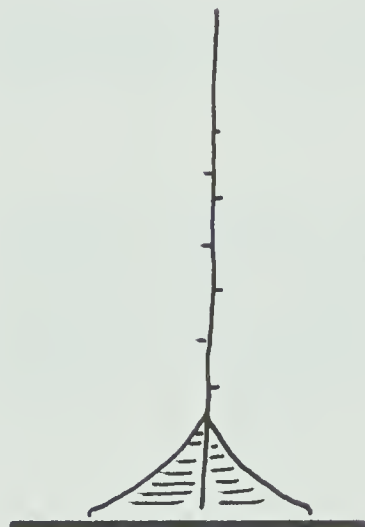
**A**



**B**



**C**



**D**



**E**



**F**





Table 7. Plant species representative of the six basic categories of physiognomic form illustrated in Figure 19.

Physiognomic form	Representative species
A	Foxtail barley ( <i>Hordeum jubatum</i> ) Manna grass ( <i>Glyceria striata</i> ) Sedge ( <i>Carex</i> spp.)(green) other grasses
B	Great bulrush ( <i>Scirpus validus</i> )(green) Threesquare bulrush ( <i>S. americanus</i> ) Wire rush ( <i>Juncus balticus</i> )
C	Stinging nettle ( <i>Urtica gracilis</i> ) Canada thistle ( <i>Cirsium arvense</i> ) Lambsquarter ( <i>Chenopodium album</i> ) Fireweed ( <i>Epilobium angustifolium</i> ) Wormwood ( <i>Artemisia absinthium</i> ) Raspberry ( <i>Rubus strigosus</i> )
D	Sowthistle ( <i>Sonchus arvensis</i> )
E	Buffaloberry ( <i>Shepherdia canadensis</i> ) Tansy mustard ( <i>Descurainia richardsonii</i> ) Pennycress ( <i>Thlaspi arvense</i> ) Rose ( <i>Rosa woodsii</i> ) Snowberry ( <i>Symphoricarpos albus</i> ) Red-osier dogwood ( <i>Cornus stolonifera</i> )
F	Great bulrush ( <i>S. validus</i> ) (dry) Sedge ( <i>Carex</i> spp.)(dry) Gooseberry ( <i>Ribes oxycanthoides</i> )

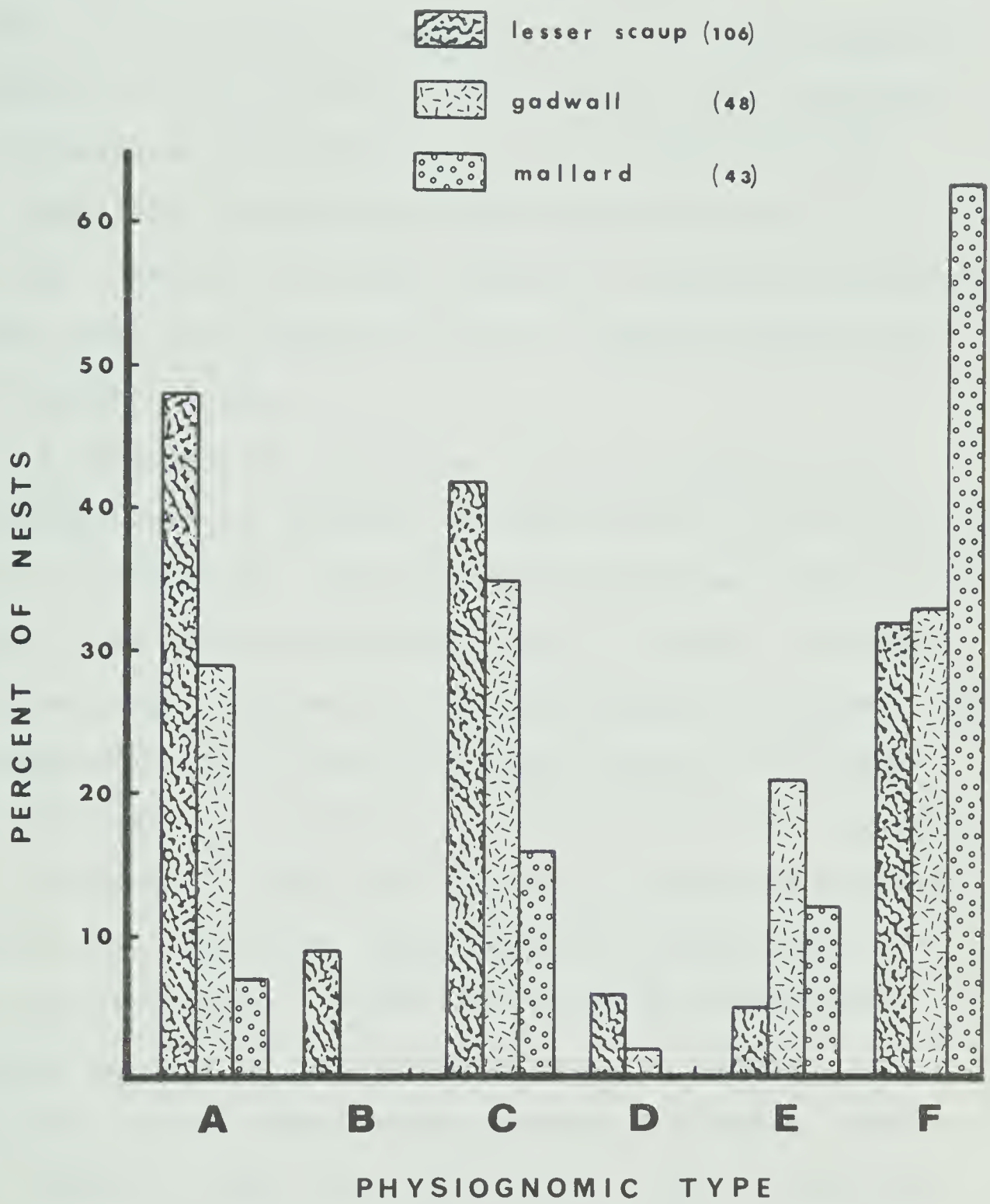


in assigning species to the appropriate physiognomic type. Type F designates the form which provides cupola-type nest sites. Such sites occur most often in dry bulrush, but also in dry sedge, and even where there is persistent dry forb material. Large gooseberry bushes, examined from ground level, are also seen to provide essentially the same type of cover.

Data on the occurrence of these physiognomic types at nests of lesser scaup, gadwall and mallard in 1969 appear in Figure 20. The patterns of distribution of nests among the physiognomic types show significant differences between all three duck species. Mallards showed a striking preference for Form F plants. Gadwall and scaup also used this form heavily. Lesser scaup appeared to prefer vegetation of Form A, but they also selected forbs of Form C. Gadwall preferred C growth form. This has been suggested by earlier studies (Duebbert 1966, Dwernychuk 1968).

Data for the availability of the six physiognomic forms are not available, making relevant evaluation of selection trends impossible. But the statistical separation of species utilization made possible by this approach suggests that meaningful results may be derived from further use of it.

Figure 20. Percent of nests of three species of ducks at which plants of six physiognomic forms occurred in 1969.







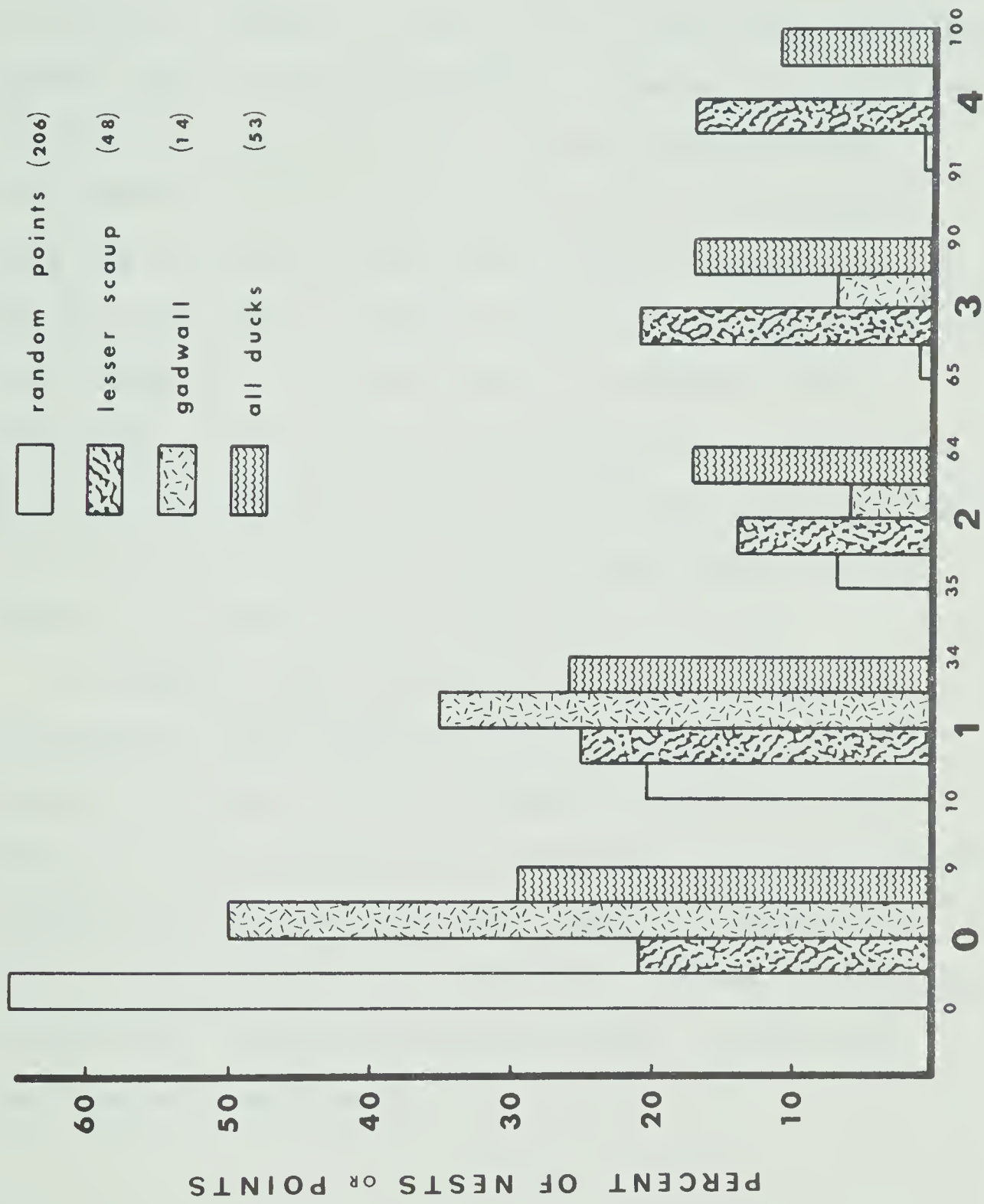
#### IV-4b. Vegetative cover at nests

Several aspects of the physiognomy of vegetation may be relevant to ducks when selecting nest sites. The degree of cover at the site is a function not only of the density of plants, but also of their shape, height, and condition.

It would be expected that the cryptically colored ducks would seek concealing conditions when selecting a nest site. Behavior of ducks exploring the nesting grounds indicate that the degree of cover is indeed important to them (Duebbert 1966).

The frequency of occurrence of five categories of vegetative cover at randomly selected points and at duck nests appears in Figure 21. The cover considered was the minimum, observed from the most exposed aspect. Randomly selected points were most frequently characterized by low cover, and the frequency of occurrence decreases rapidly for higher cover categories. In contrast, lesser scaup nests occurred almost uniformly in all cover classes, indicating positive selection for the higher cover classes and avoidance of sites with low cover. Gadwall appeared to follow the frequency pattern of the random points, in marked opposition to their reported preference for dense, rank cover (Duebbert 1966, Dwernychuk 1968). For all species combined, there was evidence of selection as in the lesser scaup, but it appeared weaker. Availability and utilization differed significantly for the lesser scaup in cover classes

Figure 21. Occurrence of five classes of cover at  
nests and randomly selected points on  
Island A in 1969.



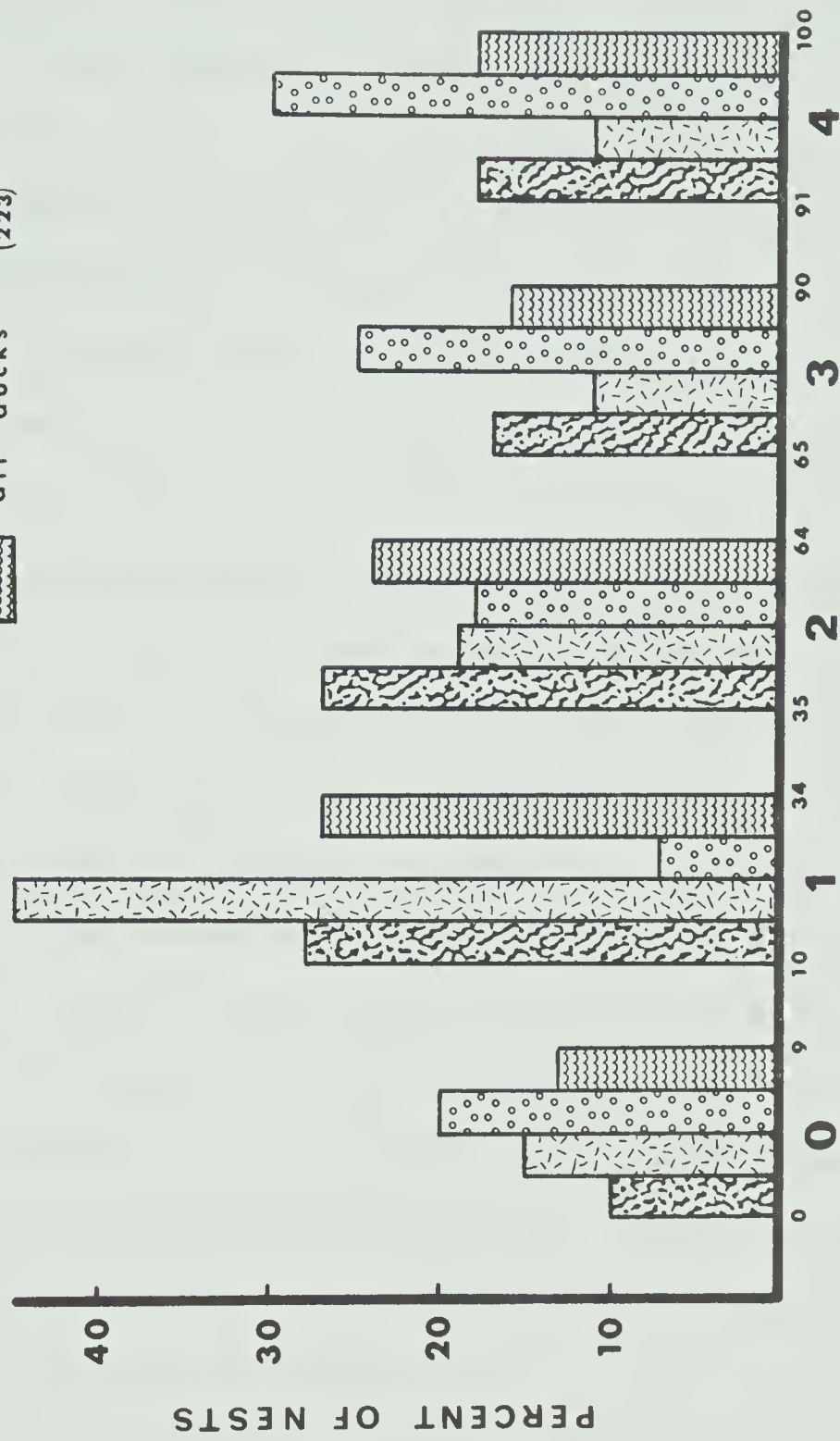
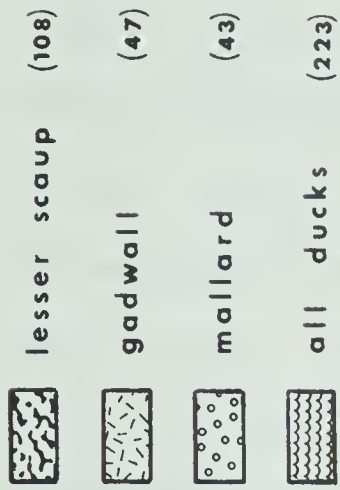


0, 3 and 4 and for combined species in all cover classes.

Similar data for the entire 1969 study area are presented in Figure 22, allowing comparison of utilization by different species. There was no significant difference between lesser scaup and gadwall. However, both differed significantly from mallards. These data show heavy utilization of sites with little cover by the gadwall. Scaup are uniformly distributed, with a tendency to use medium cover sites. Mallards appeared to seek concealing cover although very open sites were commonly used. Undoubtedly this is due to the prevalence of open sites early in the season, at the time that most mallards nest. Only the mallard did not diverge significantly from a uniform utilization of the five cover classes.

It appears that the selection of nest sites is influenced by the degree of vegetative cover. But the absence of strong selection trends suggests that this factor is less important than suggested in earlier studies. Possibly all that nesting ducks require in the way of cover is the presence of a sufficient number of stems to disrupt their outline while on the nest. Additional cover may be superfluous.

Figure 22. Occurrence of five classes of cover at nests over the entire 1969 study area.







#### IV-4c. Shading effect of vegetative cover

Weller (1959) considered the shading effect of vegetation to be an important property of a nest site. It relates to both the growth form, and density of vegetation. The data in Figure 23 allow comparison of the light intercepted by vegetation at randomly selected points and duck nests on Island A in 1969. Random points showed a distribution that is skewed towards lower interception levels, reflecting the prevalence of very open sites. The scarcity of points on the 0 to 19% interception category does not indicate that very open sites are rare. Rather, it reflects the fact that light reaching the ground is reduced even in very open areas. Gadwall appear to be the least selective for this factor. In no category was the number of gadwall nests significantly different from the number expected on the basis of random point figures. Lesser scaup were significantly more abundant in the categories of 80 to 100% and 60 to 79% interception categories, and significantly less abundant than expected in the 20 to 39% category. Nests of combined species were significantly more numerous than expected in the two high interception categories.

Examination of the data in Figure 24 reveals a significant difference between the distributions of scaup and gadwall nests in the five light interception categories. Gadwall appear to select dark sites less strongly than

Figure 23. Percent of duck nests and randomly selected points occurring in five classes of sites, based on the amount of incident light intercepted by the vegetation around the site. Data for Island A in 1969.

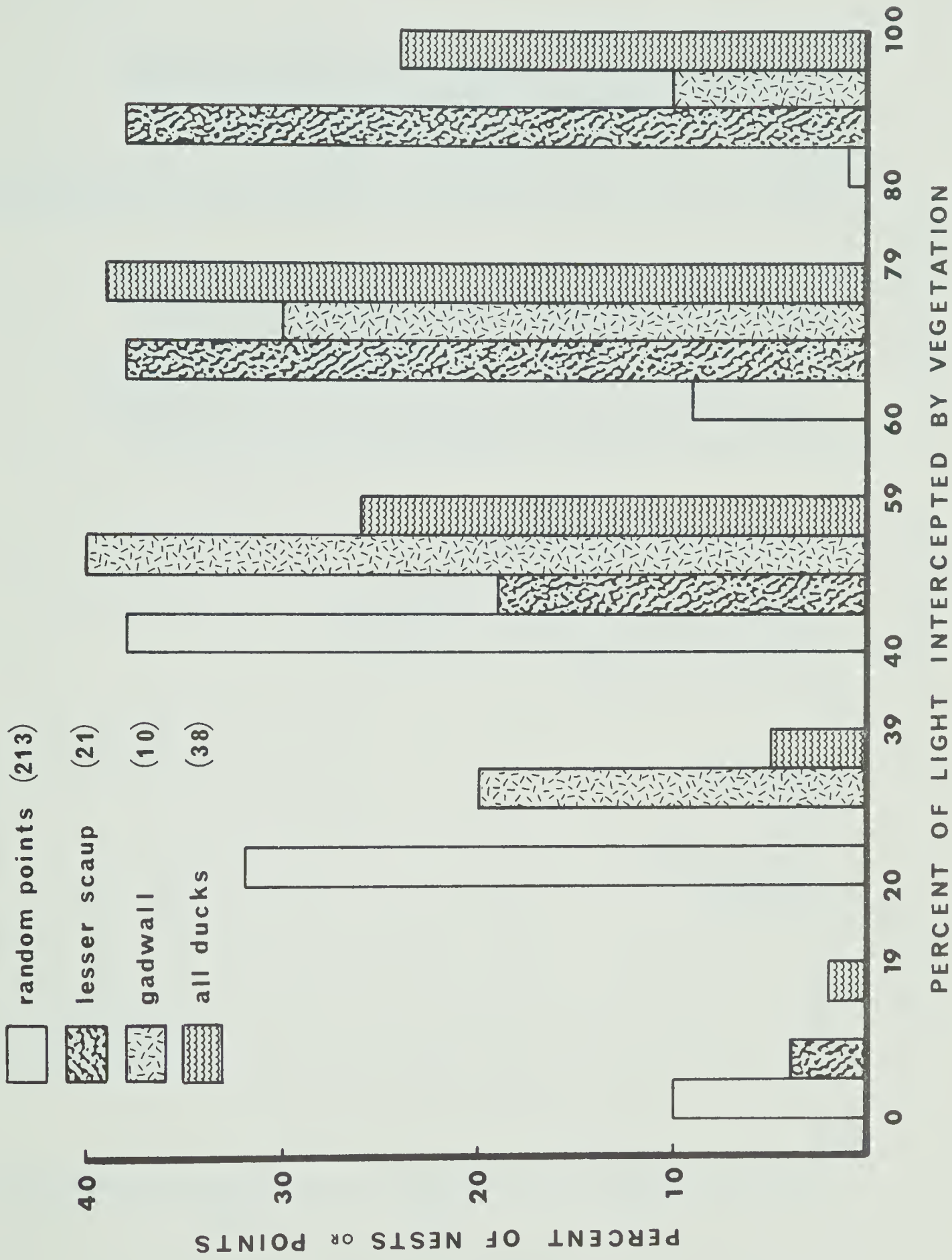
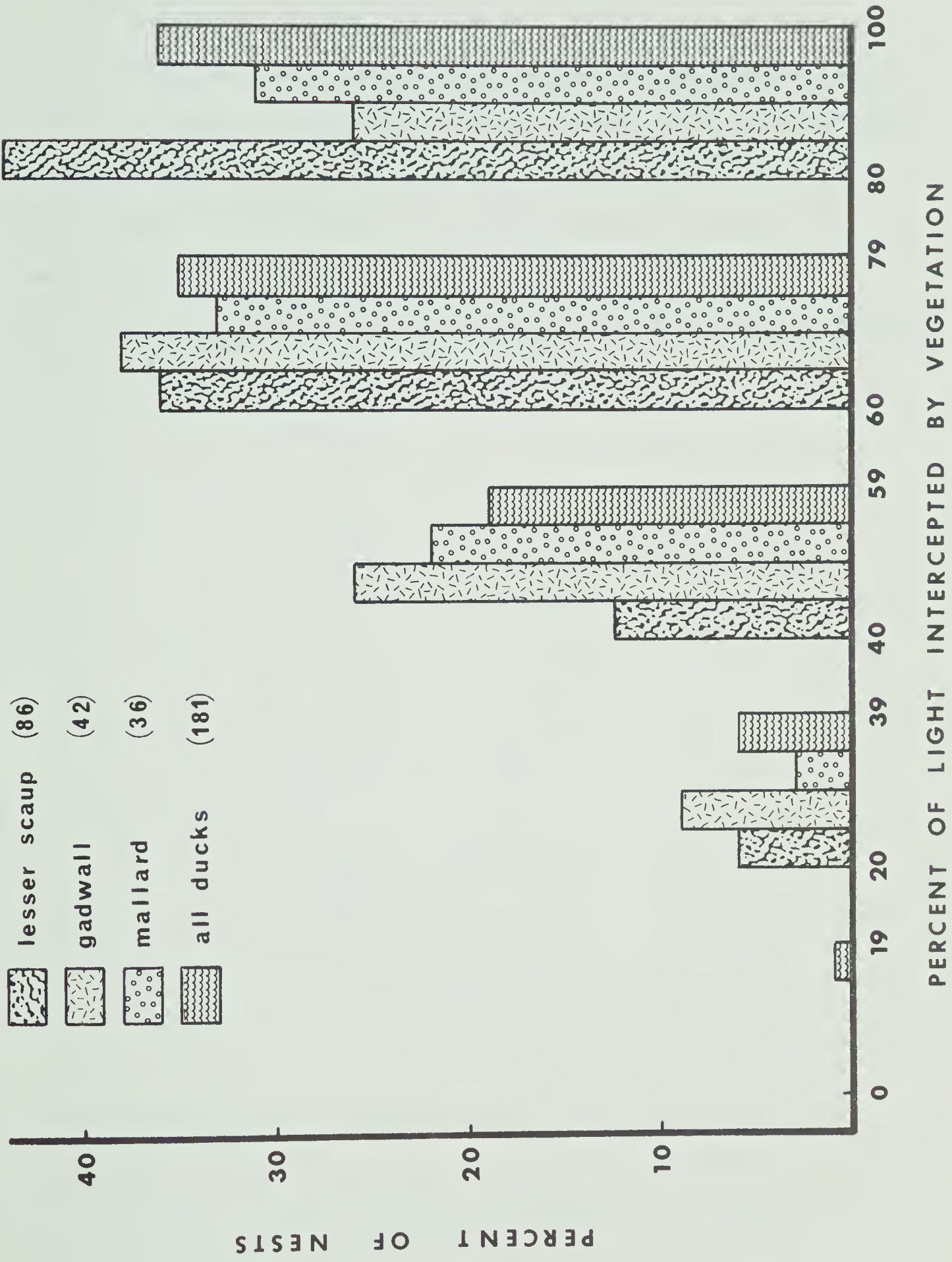


Figure 24. Percent of duck nests occurring in each of five classes of sites, defined by the amount of incident light intercepted by the surrounding vegetation. All nests found in 1969 are included.







scaup. Mallards closely parallel the distribution pattern of gadwall.

The data in these two figures indicate that lesser scaup, despite the broad tolerance for different habitats noted in Figure 16, has a stronger tendency to select dark nesting sites than other species. This tendency was not indicated in the discussion of the covering effect of vegetation. Preferences for certain growth forms in different duck species could explain the discrepancy between light transmission data and cover data.



#### IV-4d. Height of vegetation at nests

Sight is the sense of primary importance to birds, and nesting ducks would be expected to occupy habitat which allowed the use of this sense to maximum efficiency.

Height of vegetation at duck nests and random selected points on Island A are illustrated in Figure 25. The height measured was the level at which the gridded stake was no longer concealed by the vegetation (Fig. 1b). Sites with less than 1.5 dm of dense vegetation around them occurred most frequently among the randomly selected points. Both the lesser scaup and all species combined selected significantly against this low-height category. All ducks and all species combined were significantly more abundant in the 1.5 to 3.4 dm range than would be expected if selection occurred at random. In the third category, gadwall were not significantly different from the expected, and in the fourth, only the scaup occurred in disproportionate abundance.

Data for all nests in 1969 appear in Figure 26. Nests of lesser scaup occurred in much greater abundance in vegetation in the 1.5 to 3.4 dm height range. Except for the lowest height category, mallard nests occurred equally in all classes. This reflects their general habitat usage (Fig. 16) and their preference for well concealed sites (Fig. 22). Distribution patterns in the four classes showed significant differences between all

Figure 25. Percent of nests and randomly selected points occurring in four height classes of vegetation on Island A in 1969.

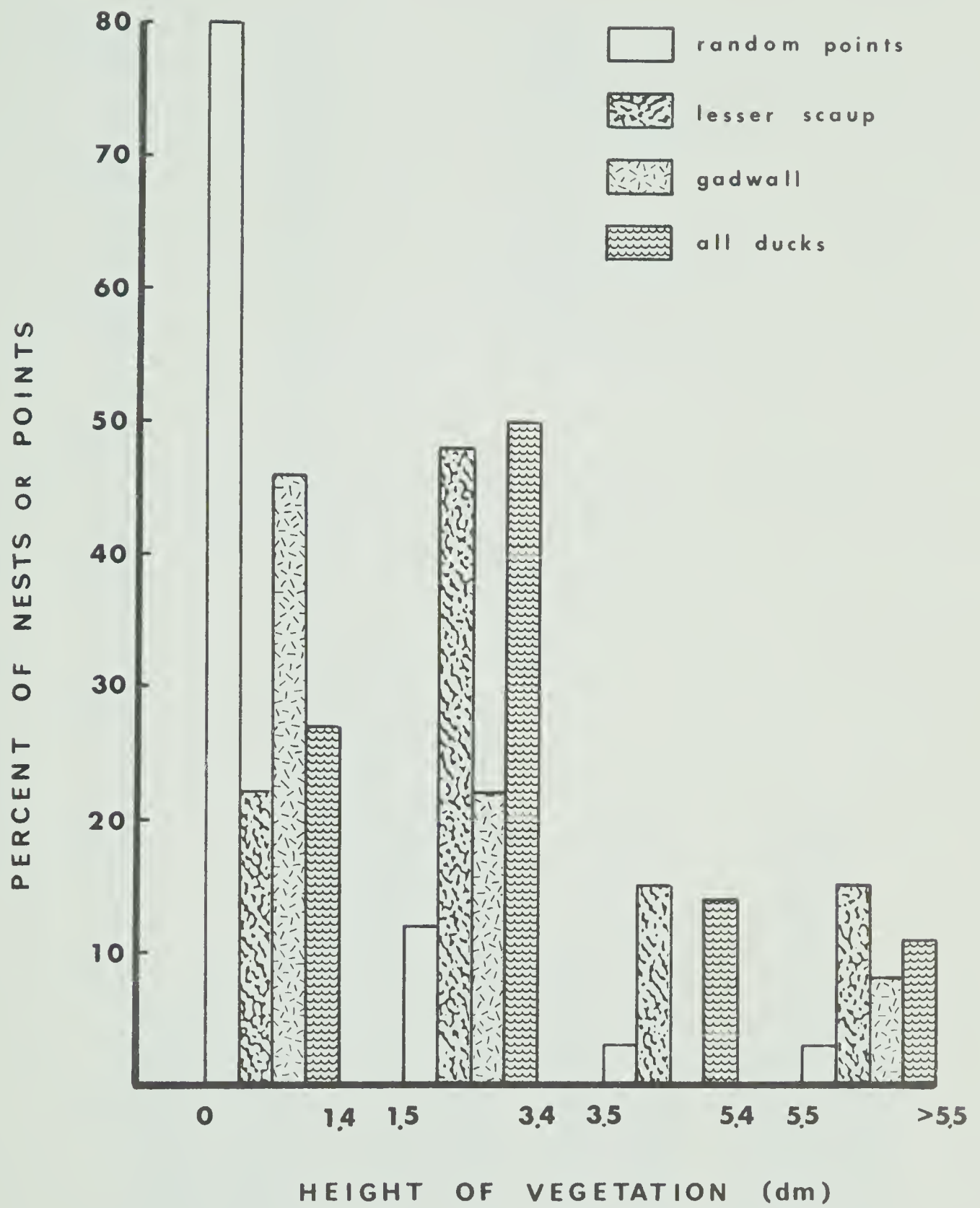
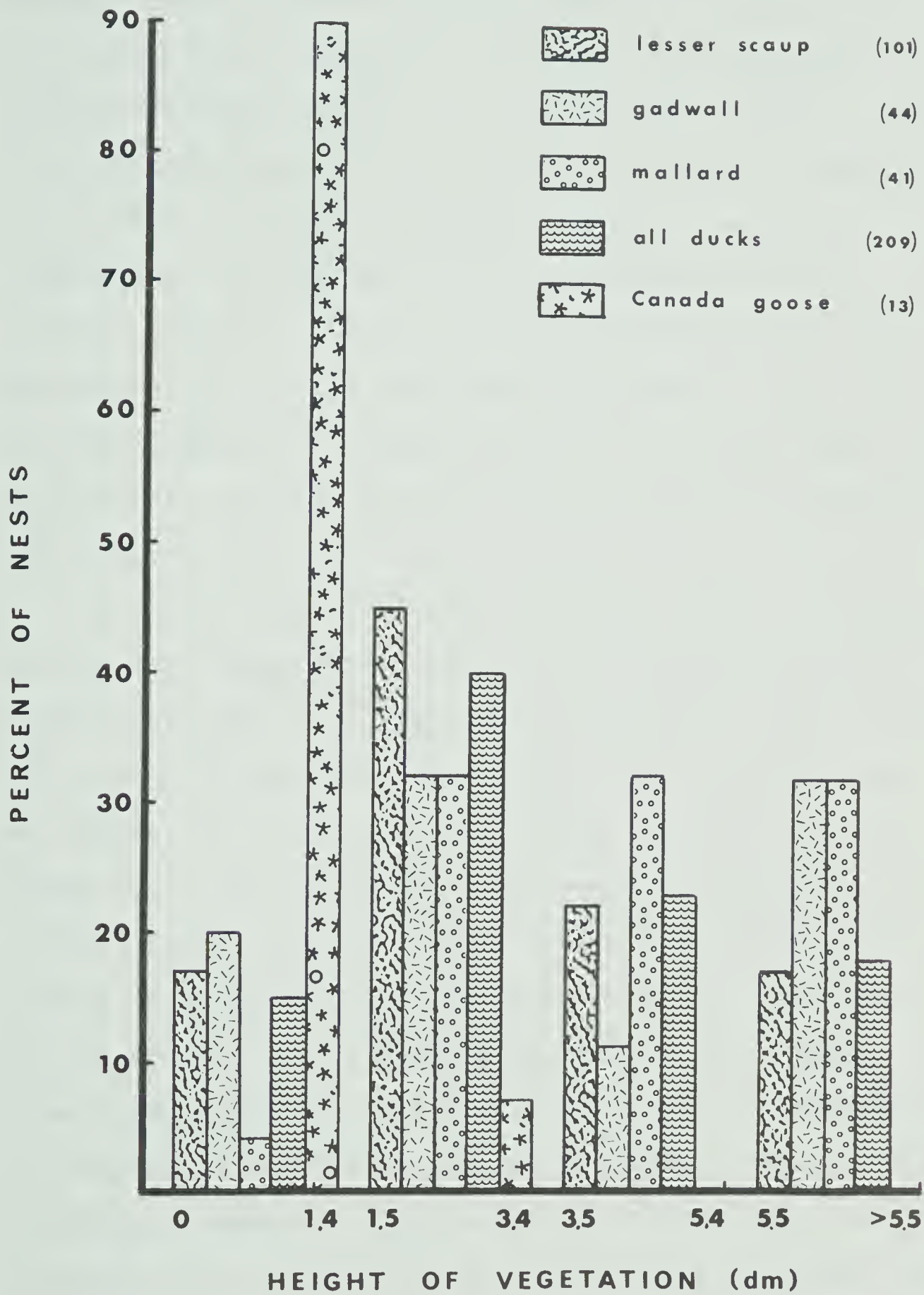


Figure 26. Percent of nests occurring in four height classes of vegetation over the entire study area in 1969.







species. The different preferences of scaup and mallard are particularly notable. The irregular distribution of gadwall nests is difficult to interpret. The scarcity of nests of this species in the 3.5 to 5.4 dm height category suggests that it is unfavourable to them. There is a possible combination of factors in effect, making the 1.5 to 3.4 dm height range most suitable, and taller vegetation suitable only if it is very much taller. Perhaps the additional cover provided by very high vegetation overrides the advantages afforded by the preferred shorter vegetation. Canada geese utilized very open sites. This likely relates to their greater ability to defend an open nest site.

The significance of the preferred height of vegetation may be correlated with a tendency for nesting ducks to seek concealing cover that would not obscure their vision. The 1.5 dm minimum height of the preferred category may be related to the size of the incubating duck (Fig. 27). Dense cover of this height would be quite sufficient to conceal ducks on nests. Martz (1967) considered eight inches (2.0 dm) to be minimal nesting cover. This falls in the lower part of the range preferred in this study. Figure 28 relates the limits of this preferred category to the height of a mallard, gadwall and lesser scaup, while standing. Vegetation to a height of 2.5 dm would not obstruct the view of any species, and only the upper limit of the category would obscure the vision of the scaup and

Figure 27. Relationship between the lower limit of the preferred range of vegetation heights (1.5 dm) and the size of incubating mallard (a) and gadwall (b).

2  
1  
0  
dm

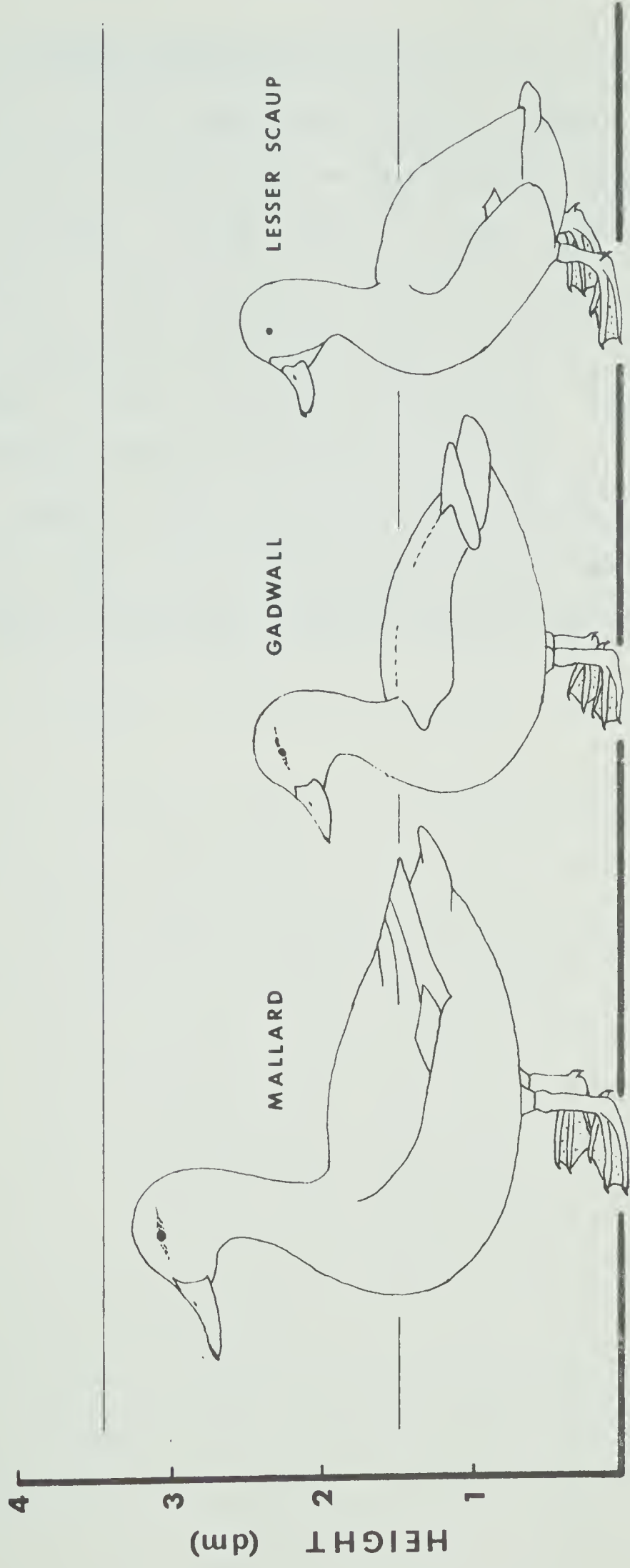


2  
1  
0  
dm



Figure 28. Relationship of preferred minimum (1.5 dm) and maximum (3.5 dm) vegetation heights to the height of mallard, gadwall and lesser scaup while standing.





redrawn from Kortright (1942)





gadwall if they stretched to a full alert posture. Vegetation in this range would allow a female to be concealed on the nest yet see approaching danger if she was so inclined. Ducks nesting in gull colonies were observed to be alerted by the alarm cries of the gulls, and they reacted by standing erect, near the nest, in an attempt to see the cause of the alarm. They flushed only when the danger was visible to them.

It appears then, that the height of the vegetation around the nest is of importance in the selection of a site. Both minimum and maximum heights may be limiting.



#### IV-4e. Plant association interfaces

If extreme reduction of the field of view of an incubating duck is an undesirable property of a nest site ducks would likely prefer sites located near the edge of dense cover. The vegetation on the islands studied produced abundant interfaces between plant associations. These were chiefly interfaces between low, open areas and stands of dense growth. Martz (1967) found that areas of lush growth surrounding mowed fields had higher densities of nesting ducks than similar areas around unmowed fields. This suggests that the degree of difference in height and density of vegetation at an interface is an important factor.

The relationship of nests and of randomly selected points to plant association interfaces is summarized in Table 3. While 40% of randomly selected points had no interface within 3 m, lesser scaup, gadwall, and all species combined, had fewer than 18% of nests so located. Further, 34% of random points were located on the more exposed side of an interface while less than 9% of duck nests were so located. There was tendency for nesting ducks to situate within 3 m of plant association interfaces, in the denser vegetation.

Data on the distance of the nearest plant interface to randomly selected points and duck nests appear in Figures 29 and 30. The random points in Figure 29 closely

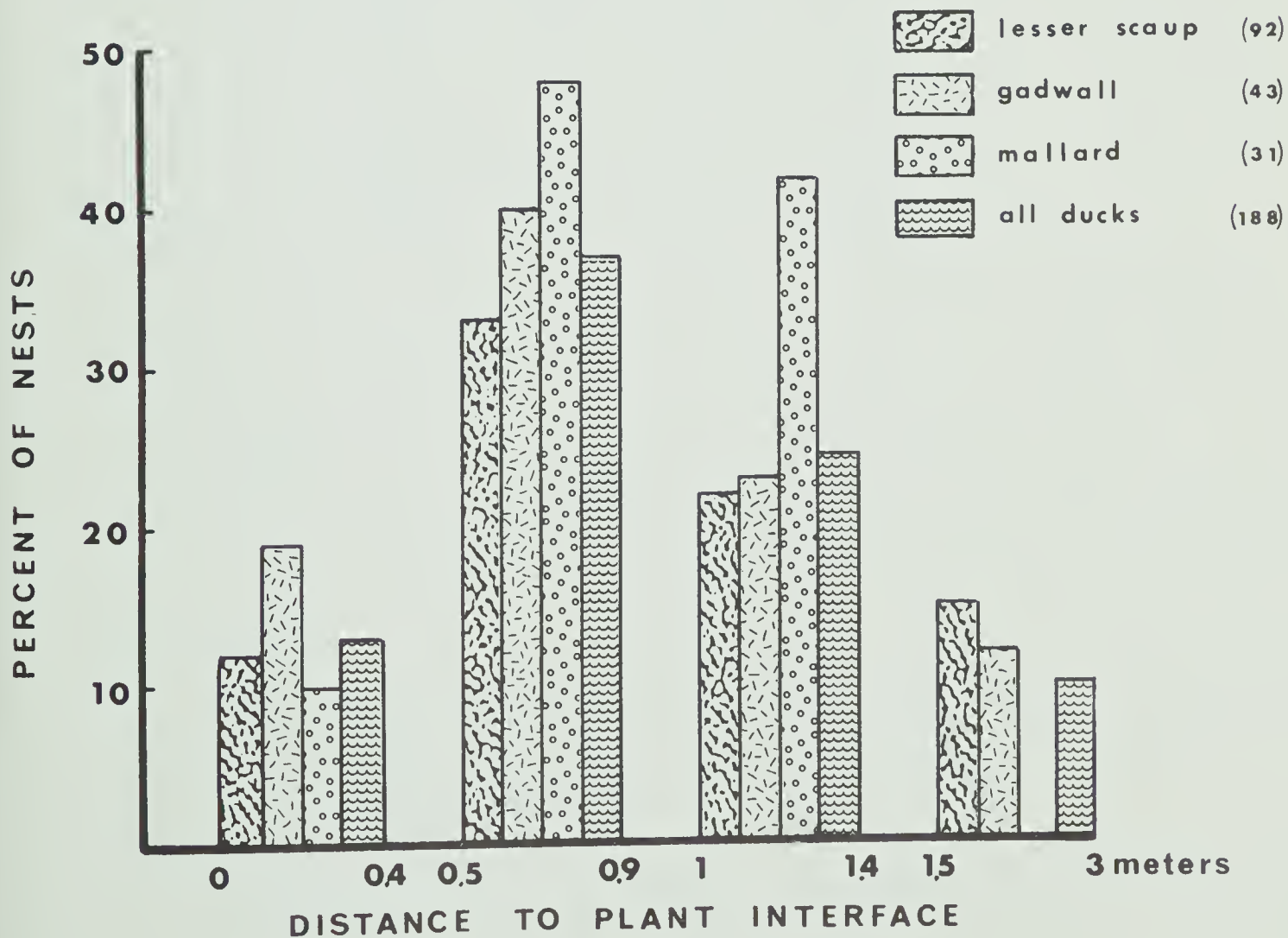
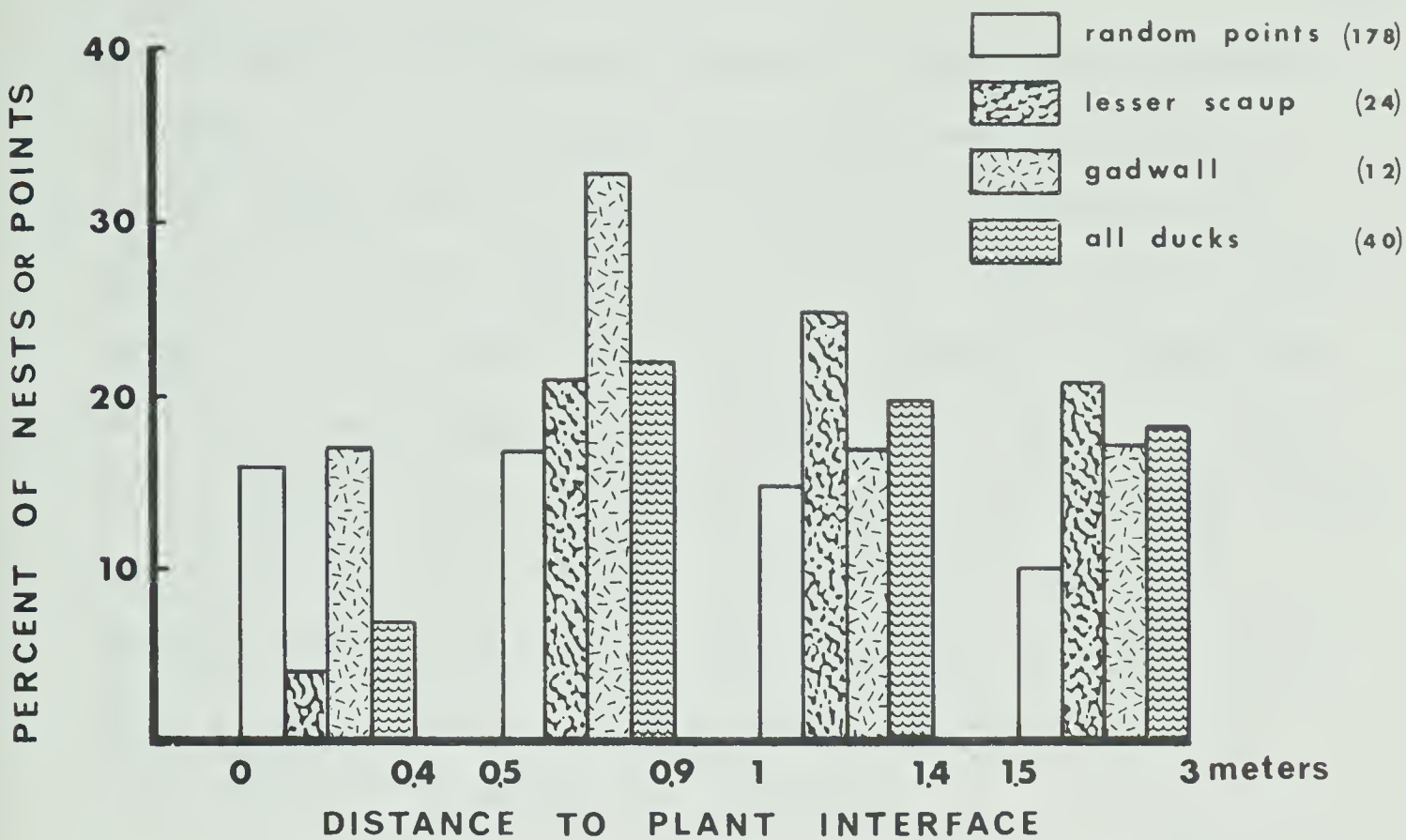


Table 8. Relationship of nest locations and randomly selected points to plant species association interfaces.

	Percent of total			
	No interface within 3 m	In dense vegetation	In sparse vegetation	Total
Random points	40	26	34	178
lesser scaup	18	77	5	92
gadwall	11	80	9	45
mallard	3	94	3	31
all species	15	80	5	186

Figure 29. Occurrence of duck nests and randomly selected points in four ranges of distance from the nearest plant association interface (Island A, 1969).

Figure 30. Occurrence of duck nests in four ranges of distance from the nearest plant association interface (All nests, 1969).







approximate a uniform distribution in the four distance categories. The distribution of duck nests does not differ significantly from a uniform distribution, but there is a trend suggesting selection of the 0.5 to 1.4 m range. This trend is emphasized strongly in Figure 30, with all groups appearing to prefer this range. If this is an indication of preference, then it follows that a very heterogeneous environment - with abundant interfaces between sparse and dense vegetation - would contain many more sites suitable for duck nests, at least as far as the interface parameter is concerned.



#### IV-5. ORIENTATION OF NESTS

Most of the duck nests examined during this study were incompletely surrounded by vegetation. Each at least had an opening in the side by which the duck habitually entered and left. The possibility that direction of exposure of the nest site was important to its selection was considered. As might be expected in an island situation where the ducks often return to the nest on foot, a preferred orientation in the direction of the nearest water was found (Fig. 3). Only the gadwall failed to orientate significantly toward water, possibly because of their habit of flying, rather than walking to the nest.

The direction of nest exposure is related to compass direction in Figure 32. In the analysis of these data, a nest was assigned an orientation in a maximum of two directions, based on the relative amount of opening in each direction. The random points on Island A approximate a uniform distribution in all directions. In other cases the strongest orientation was to the southeast. This orientation was statistically significant only when lesser scaup and all species combined were examined for the entire study area.

It is unlikely that orientation is to compass direction itself, but more likely the selection involved is for a factor that is itself direction oriented.

An opening in any direction corresponds to the location

Figure 31. Orientation of nest openings with respect to nearest water. Nests from the entire 1969 study area. Not all nests exhibited an orientation to water.

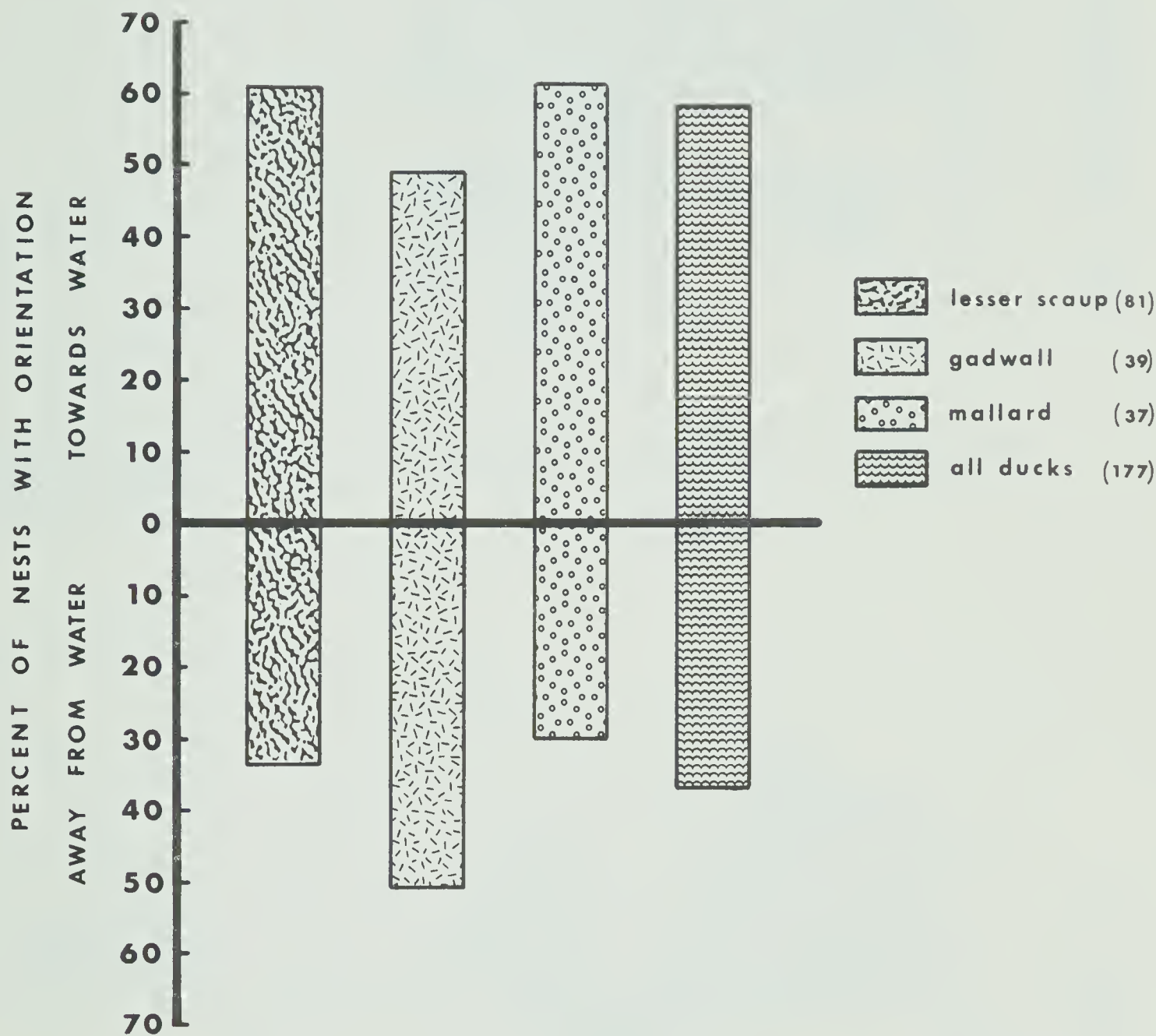
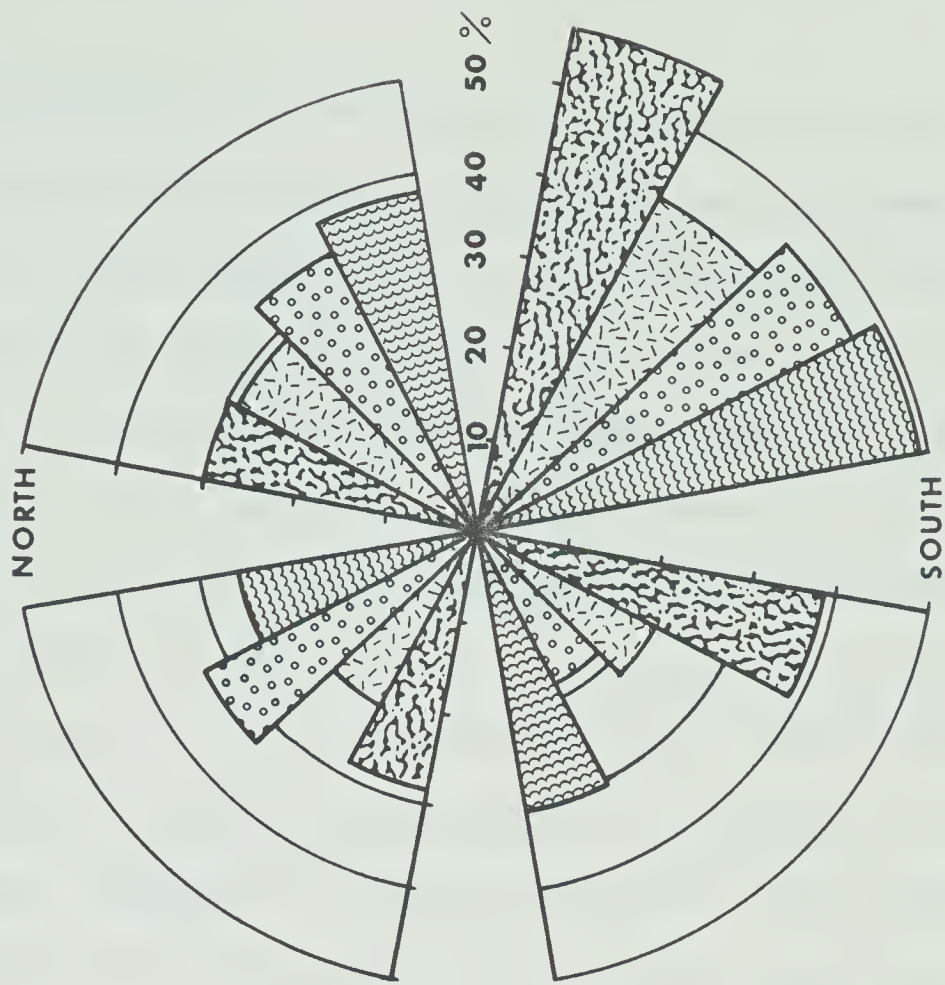
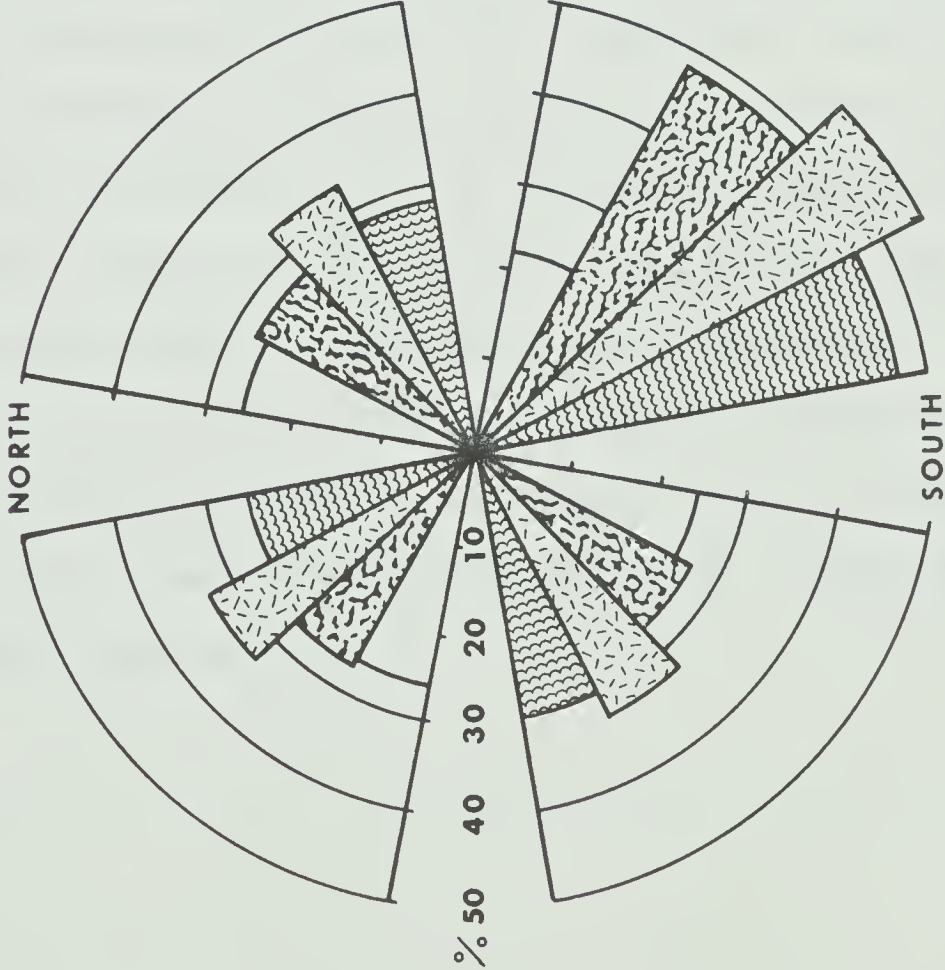
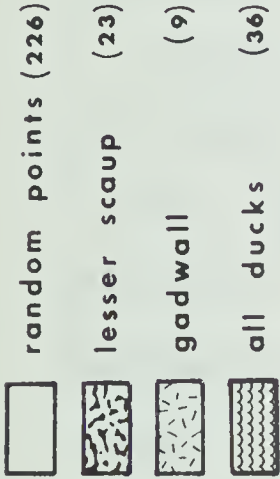


Figure 32. Orientation of nests with respect to  
compass direction.







of thicker vegetation on the opposite side of the nest. There are two possible explanations for the southeast orientation of nest openings. In this latitude, the spring sun rises north of east, and sets north of west, having made an arc to the south of the east-west axis during the day. Southeast openings would minimize exposure to the hottest sun of the day. Weller (1959) considered that the shading effect of the vegetation was an important property of a nest site, and there is little doubt that an incubating bird suffers discomfort if exposed to hot afternoon sun. However, if shade alone were the factor directing the exposure of duck nests, there would be a greater orientation to the northeast than the data indicate.

Wind action for the period of September 1968 to July 1969 is summarized in Table 9. The prevailing wind is from the northwest. It is possible that this may have resulted in an orientation of dry vegetation towards the southeast, but this was not reflected in data for the randomly selected points. During the period of May to July when the ducks are establishing nests, the northwest wind was even more prevalent. It appears likely that the ducks are actually selecting sites that are in the lee of clumps of dense vegetation.



Table 9. Summary of wind for the period, September 1968 to July 1969. Records from the University of Alberta Department of Meteorology station at Ellerslie, Alberta.

Values are total miles in each direction.

Direction	1968					1969							Total
	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July		
N	86	55	131	175	108	77	65	97	379	300	94	1567	
NE	416	58	204	241	198	135	606	486	786	1074	361	4565	
E	47	11	6	116	122	323	117	344	334	567	296	2283	
SE	656	1795	926	1688	676	2305	1352	2126	1060	523	732	13748	
S	576	839	1731	430	780	897	1123	970	455	431	663	8895	
SW	537	588	984	184	610	340	786	482	503	504	786	6304	
W	282	336	592	256	268	195	330	357	354	362	578	3910	
NW	3029	2217	680	2766	640	248	957	1835	2059	1155	1956	17542	





IV-6a. Spacing patterns

Solitary nesting facilitates nest concealment (Lack 1968), and dispersion of nests may serve an anti-predation function (Hammond and Mann 1956, Tinbergen 1963, McKinney 1965). It might be expected that cryptically colored ducks would have developed a mechanism for insuring the dispersion of nests to obtain maximum advantage from their cryptic adaptations.

Spacing patterns on certain islands were analysed using Cox's (1967) random pairs test. Results of these tests appear in Table 10.

In a heterogeneous environment, selection for specific properties of the habitat would result in a clumped distribution of animals (Odum 1959). A spacing mechanism, involving social interaction would result in a tendency toward a uniform distribution. A combination of habitat selection and social interaction might therefore result in a dispersion pattern that approached randomness. For lesser scaup, a random pattern of distribution was found most frequently. On island A in 1968, the first 9 scaup nests were established in a pattern that deviated significantly from randomness in the direction of uniformity. When the first 18 nests were considered, the tendency towards uniformity was not significant. The 30 nests present on the date of peak abundance exhibited an almost perfect random distribution. The only instance in which a clumped pattern of scaup nests was indicated was on island S in 1968 where there was an anomalous high nest density. These data suggest that nest site selection is influenced both by environmental factors, and by interaction among the nesting





Table 10. Spacing patterns of lesser scaup nests present on the day of peak abundance, and of all nests established, in four island/years. Patterns were determined using Cox's (1967) random pairs method.

Group and Location	Number	Pattern
<hr/>		
Lesser scaup		
Island S - July 18, 1968	43	clumped
Island B - June 15, 1969	13	random
Island A - June 30, 1968	30	random
Island A - July 15, 1969	20	random
All nests		
Island S - 1968	70	random
Island B - 1969	39	clumped
Island A - 1968	78	clumped
Island A - 1969	50	random
<hr/>		



ducks. The early nesting individuals would be able to space themselves evenly because of the abundance of unoccupied habitat. As nest density increased later in the season, the uneven distribution of suitable sites would restrict the ability of the birds to maintain maximal spacing. At extreme densities, the effect of the spacing tendency would be completely overruled by selection for suitable environmental conditions.

Interspecific territorialism is rare among different species of ducks co-habiting the same nesting areas (McKinney 1963). Dispersion of nests of several species would therefore be expected to exhibit a greater tendency towards a clumped distribution than would those of a single species. Clumped distributions were indicated in two of four situations examined (Table 10). However, the analysis is complicated by the fact that all nests were not active at any one time.

The data presented here suggest that there may exist a mechanism which tends to space duck nests within suitable habitat. It also appears that the tendency towards maximal spacing is of less importance than selection of favorable environmental conditions.



#### IV-6b. Territorial spacing and spacing of nests

Territorial behavior in ducks is poorly understood. Usually the drake defends a small part of his home range which centers on the female. Usually there are one or two specific sites which are habitually used as loafing spots by the pair, and consequently take on the appearance of "defended areas". Hochbaum (1944) and Smith (1955) suggest that the primary function of the "territorial" activity is to guarantee isolation of the pair for copulation, and to protect the female from attack by unpaired males during the laying and early incubation periods. Alternately, sexual (territorial?) chasing in the pintail may bring about a spacing of nests over the available habitat (Smith 1963). Delacour (1959) states that crowding of nests into preferred habitat is common because the nest is not included in the territory. The situation with the lesser scaup is further complicated by the fact that they are an undemonstrative species rarely exhibiting territorial aggression. Mendall (1958) suggested spacing of pairs by "mutual respect" in the ring-necked duck. I have observed a definite spacing of loafing pairs of scaup on the shores of Islands A and B, indicating that there might also be a passive mechanism in effect here too. In any effective spacing mechanism, there must be a withdrawal behavioral component in response to an attack component. Possibly in the non-aggressive Aythyini spacing occurs through avoidance alone.

If territorial spacing of pairs on loafing areas is





effecting a dispersion of nests on the islands of the study area, the spacing must occur on the shores of the island on which the female nests. Further, the site of the nest must be adjacent to the "territory", being as close as the nesting habitat will allow.

In order to examine the possible relationship between nest site location and loafing sites, Islands A and B were divided into four sectors, such that any point in each sector was closer to the shore of that sector than to the shore of any other sector. The number of sightings of lone drakes and pairs loafing on the shores of each sector was compared with the number of nests located in that sector.

The numbers of sightings and nests associated with each of the four sectors of Islands A and B are shown in Figure 33. These numbers were treated as follows:

for any sector:

$P_{si}$  = the proportion of all sightings of loafing ducks made in that sector.

$P_{sh}$  = the proportion of the total shoreline included in the sector.

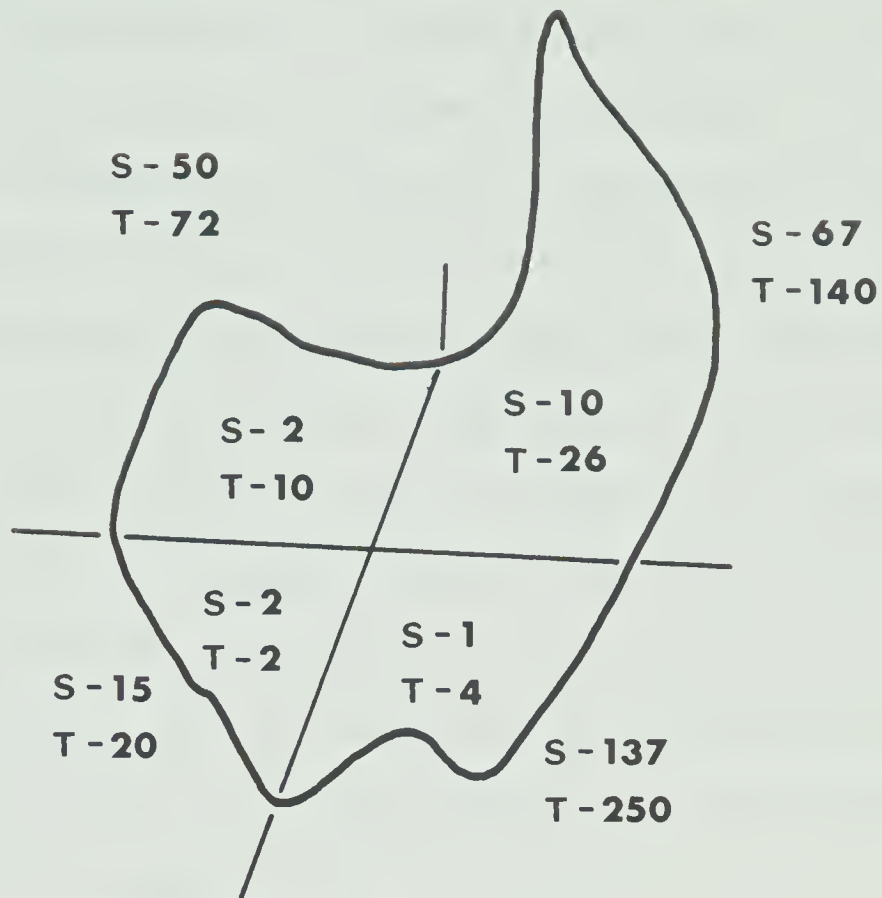
$P_a$  = the proportion of the total area included in the sector.

$P_n$  = the proportion of all nests located on the island that would be expected to be located in the sector if there was a correlation with  $P_{si}$ .

$$\frac{P_{si}}{P_{sh}} = \frac{P_n}{P_a}$$

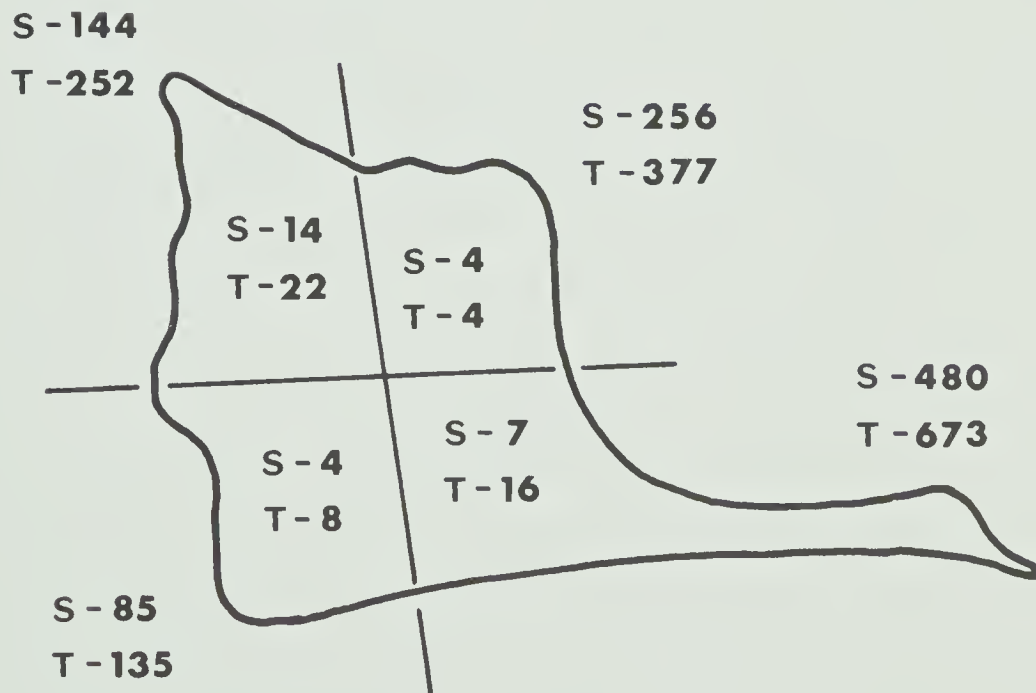
$P_n$  and the observed proportion of nests are tested statistically.

Figure 33. Numbers of sightings of loafing ducks (outside) and numbers of nests (inside) associated with each of four sectors on Islands A and B, 1969.



**ISLAND B**

S = lesser scaup  
T = all ducks



**ISLAND A**



On both islands there was a significant difference between the distributions of loafing sites and of nests for the lesser scaup, and for all species combined. It appears unlikely that there is any relation between the sites used as loafing areas, and the site of the nest.

Examination of the locations where ducks were observed in relation to the direction of the wind at that time showed that ducks exhibit a strong tendency to choose loafing sites on the leeward side of the island (Table 11). Since wind direction is variable, it is unlikely that "territorial" activity, as evidenced by the position of loafing sites, could in any way affect the distribution of nests on the islands.



Table 11. Observations of loafing ducks on the windward and leeward sides of Islands A and B in 1969.

	Percent of Total		Total
	Windward	Leeward	
Island A	24	76	1153
Island B	40	60	390
Total	28	72	1543





#### IV-6c. Interactions among nesting females

In the two preceding sections I have discussed the possible existence of a mechanism for the spacing of duck nests, and the fact that "territorial" spacing of drakes likely has little influence on this. The remaining possibility is that the females space themselves on the nesting grounds as they select nest sites. Evidence for this hypothesis is circumstantial, but the concept is worthy of discussion.

Hammond and Mann (1956), in a discussion of waterfowl nesting at high density on islands, suggested that social interference may be a factor limiting the density of nests. Miller and Collins (1953) attributed desertion, the primary cause of nest failure in their study of Canada geese, to intraspecific strife. On Island S in 1968 it appeared that social interference resulted in aberrant nesting occurrences. The vegetated portion of this island consisted of 950 square meters of rocky ground with sparse cover except for a partial rim of bulrush and a few aspens. Within this small area, a total of 70 duck nests were constructed, including 54 lesser scaup, 15 gadwall, and 1 redhead. There were between 30 and 50 nests present at any time until late July, yet at no time did more than 15 ducks flush as the island was searched. This indicates that attentiveness was at a reduced level. Over 100 eggs were found scattered over the island, isolated from any nest. These were collected and incubated: only four hatched.



Only 57% of nests contained any down, and most of the remainder showed little construction beyond initial stages. Nest parasitism was common. The average clutch for the lesser scaup was 11.8 (5 to 32) compared to an 8.9 (6 to 18) at Miquelon Lake in the same year. This suggests a high incidence of intraspecific parasitism among lesser scaup on islands. Twenty seven percent of nests contained the eggs of two species, usually scaup eggs in gadwall nests. An additional 5% of nests contained the eggs of scaup, gadwall and redhead. By comparison, only 13% of nests at Miquelon Lake showed signs of parasitism. Figure 34 illustrates anomalous nesting on Island S.

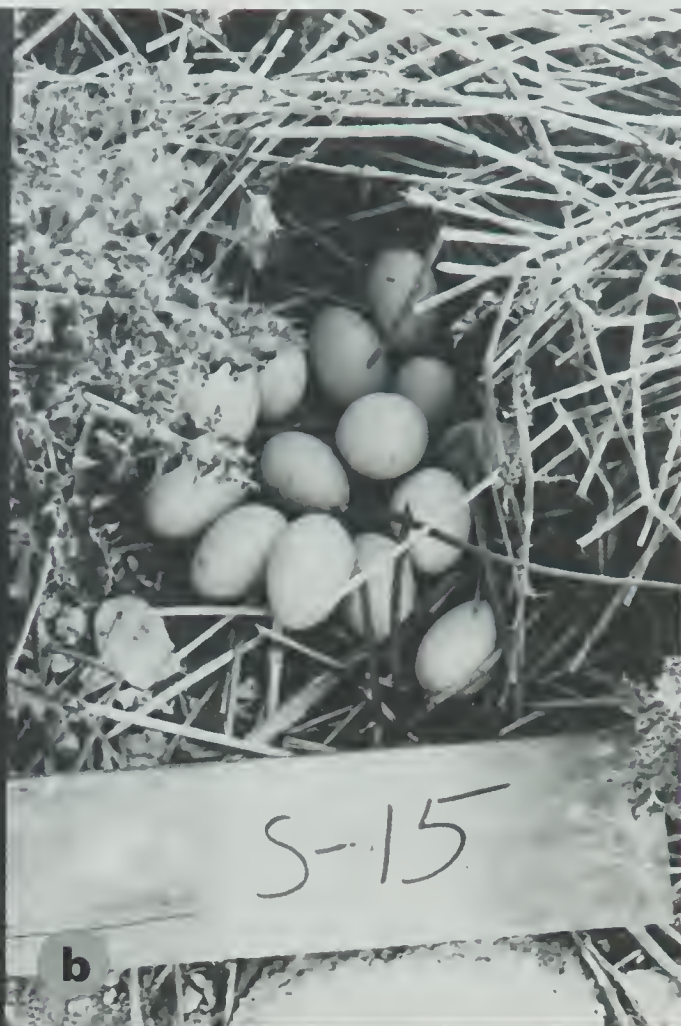
Nesting success was very low on Island S, with only 21% of nests hatching an egg. No nest was completely successful. Of over 1,000 eggs layed on the island, only 2 to 4% hatched. Artificial incubation of some eggs indicated that infertility was frequent, and reduced attentiveness on the part of the females lead to many embryonic deaths and to predation. The latter was catastrophic. On July 25, I found two crows on Island S and most of the duck eggs had been destroyed. The shells of the eggs showed typical signs of crow predation (Rearden 1951). On August 5, there were no intact eggs on either Island S or Island R.

The above account points out the advantages of dispersed nesting on two counts: 1) the apparent degradation of

Figure 34. Anomalous nesting and laying on Island S  
in 1968.

- a) A nest containing 32 eggs of lesser scaup
- b) A poorly constructed nest containing eggs  
of redhead and lesser scaup
- c) A clutch of gadwall eggs in a shallow  
scrape
- d) Lesser scaup eggs - no nest construction









nesting behavior where ducks are nesting in extreme concentrations, and 2) the catastrophic nature of predation once the concentration of nests is located by predators.

Records of aggressive behavior in ducks at the nest are sparse. Hammond and Mann (1956) report a mallard female repulsing crows. Sowlis (1955) reported a female canvasback engaging a parasitic redhead in such vigorous combat that the former's nest was destroyed. I have observed a female pintail attack and repulse a drake which attempted to follow her and her mate to the nest. Her drake made no attempt to aid in repulsing the intruder.

There may exist a behavioral mechanism which normally spaces duck nests through interaction among the females. There may even be a "nesting territory" maintained by the female.

The nature of interaction among females was investigated by observing the reaction of established ducks to the presence of a mounted dummy placed near the nest. An insufficient number of these experiments were performed to yield quantitatively meaningful data. Qualitative observations were obtained. Dummies were probably recognized as ducks by both nesting ducks and gulls, although the lack of motion may have been alarming. Ducks were much more uneasy when faced with the control object than when faced with a dummy. No duck flushed when a dummy was withdrawn although it bounced unnaturally along the uneven ground. All ducks flushed when the control



object was moved. When a dummy was drawn through a colony of ring-billed gulls (*Larus delawarensis*) they reacted as they did when a duck moved among them - ignoring it unless it came close to a nest, when the incubating gull would make aggressive lunges at it. The gulls rose in alarm when the control object was moved among them.

The reactions of nesting ducks to the dummy were varying degrees of alarm. None showed overt aggression towards the dummy. Several appeared to be vocalizing. Without exception, the presence of the dummy caused an increase in the time elapsed between the duck's return to view and the time she re-entered the nest. No duck re-entered the nest in the presence of the control object, but several did so when dummies were in position. The degree of alarm was variable. Ducks appeared to be more alarmed by the presence of a dummy of their own species than they were by the presence of that of a different species. One gadwall delayed her approach for over 90 minutes until a conspecific dummy was withdrawn, yet she re-entered the nest after only fifteen minutes in the presence of a scaup dummy. A lesser scaup was so agitated by the presence of a conspecific dummy that she broke and ate one of her own eggs and flew off with the shell. The significance of this behavior is not known.

If the presence of a conspecific is more disturbing than the presence of another species, this could be the basis of a mechanism of spacing by avoidance as suggested by



Mendall (1958). Brown (1964) suggested that territorial behavior in the vicinity of nests of cryptically colored birds would be detrimental in attracting attention to the vicinity of the nest. If true, the above mentioned mechanism is ideally suited to ducks.



## IV-7. RELATIONS BETWEEN DUCKS AND OTHER SPECIES

IV-7a. Nesting ducks and geese

Eleven nests of Canada geese were established on the islands of the study area in 1969. At the same time that the geese were active on the nesting ground, only mallards and pintails were engaged in nesting activity. The number of early mallard nests located within 30 m of Canada goose nests and the proportion of the total study area represented by this radius are related in Table 12. There is a striking disproportion that is difficult to interpret on any basis other than selection of nest sites in the proximity of goose nests. Very few mallards commenced nesting before geese. Geese usually selected elevated, very open sites for nesting, while the mallard preferred good cover (Fig. 21). In view of this, it is unlikely that selection for similar cover is a factor.

Ducks would have little difficulty in locating nesting geese - they are large, and conspicuous during early nesting activities. Ewaschuk (pers. comm.) has observed many instances in which ducks moved about among nesting geese and were apparently tolerated completely. There would be advantage in establishing near to a goose nest. The geese are adept at keeping predators away from the vicinity of their nests, and consequently from the nests of closely located ducks.





Table 12. Numbers of mallard nests established while Canada geese were present on the islands, over the entire study area, and within 30 m of a goose nest.

	Early mallard nests		Area (ha)	
	no.	%	no.	%
Total study area	23	100	26	100
Within 30 m of a goose nest	11	42	.28	1.2



#### IV-7b. Nesting ducks and larids

There is increasing evidence suggesting that many waterfowl species are attracted to nest within colonies of gulls or terns. The long-standing Finnish literature on the subject, is summarized by Koskimies (1957). There is disagreement among European workers on the cause, mechanism, and function of these associations. In North America, there is little literature on anatid-larid associations. Dwernychuk (1968) found no evidence that nesting ducks were attracted to colonies of ring-billed gulls and California gulls (*L. californicus*). Vermeer (1968) was convinced that lesser scaup were selecting nest sites in association with common terns (*Sterna hirundo*).

This study produced additional evidence for an association between ducks and larids. Records of larid nests established on the islands of the study area for the period 1964 to 1969 appear in Table 13.

Island A was used by a small colony of common terns in both 1968 and 1969. The colony was located on the northwest corner of the island. In 1968 they located on a long, rocky elevation and this elevation was also used heavily by nesting ducks. During the 1968 season, dense forb growth made the elevation unsuitable for tern nesting after late June. Terns nesting after that time established on the newly formed Island E. In 1969, declining water levels allowed the northwest shores of the island to dry, creating a new area suitable for tern nesting, and a colony



Table 13. Numbers of larid nests on the study area from 1964 to 1969

	Island	1964 <sup>a</sup>	1965 <sup>a</sup>	1966 <sup>b</sup>	1967 <sup>b</sup>	1968	1969
Ring-billed gull ( <i>Larus delawarensis</i> )	A	315	58	20	0	0	0
	B	(1200) <sup>c</sup>	387	(1100)	(1100)	(1500)	(1500)
California gull ( <i>Larus californicus</i> )	A	470	87	-	0	0	0
	B	(300)	44	-	-	(100)	(30)
	M	-	-	-	-	(300)	(300)
Common tern ( <i>Sterna hirundo</i> )	A	1	0	-	0	15	(25)
	D	-	-	-	-	3	18
	E	-	-	-	-	17	91
	R	-	-	-	-	(20)	0
	S	-	-	-	-	(30)	0
	T	-	-	-	-	(45)	0

a Vermeer 1967  
b Dwernychuk 1968  
c estimated number





located there among sparse manna grass and goosefoot. The elevation, despite its good residual and green cover, was used by fewer ducks than in 1968, but nine nests of scaup and gadwall were located close to the water, in very open sites, near to the tern colony. It appeared as though the ducks were selecting inferior sites in order to locate near to the terns (Fig. 35). Hildén (1965) reports a similar situation.

In an attempt to quantify the quality of nest sites, a table of values was set up which assigned high scores to nests which had characteristics in the ranges preferred by most ducks in 1969 (see Appendix III). Nests located within 30 m of tern nests were evaluated and compared to nests on all other parts of the island. Table 14 presents the results of this attempted quantification of nest site quality. For most criteria, nests located near to tern nests scored lower than those located elsewhere. The difference between average totals was not significant. This does not necessarily negate the argument, as several nests classified as being near to terns were located on the elevation where excellent nest sites were available.

Events on Islands R and S in Oliver Lake also suggest an association between ducks and common terns. The situation on Island S was described in Section IV-6c. At the same time, Island R was the location of 18 lesser scaup nests and 2 gadwall nests, in an area of less than 400 m<sup>2</sup>. Common terns nested on both Islands R and S in moderate

- Figure 35. Habitat used by ducks locating nests near to common tern nests on Island A in 1969.
- a) Common tern at its nest.
  - b) Open mud-cobble shore typically used by nesting common terns.
  - c) Gadwall nest.
  - d) Gadwall nest in sparse foxtail barley.
  - e) Lesser scaup nest.
  - f) Lesser scaup nest in sparse manna grass.









Table 14. Results of attempted quantification of the quality of duck nest sites located within 30 m of tern nests and elsewhere on Island A. Data presented are average scores for the nests in each category (see Appendix III).

	Nests located near terns	Nests located elsewhere	Maximum score
habitat type	2.1	4.1	4.3
physiognomy of vegetation	3.9	3.7	4.2
cover value	1.6	2.1	2.8
light transmission	1.8	2.9	3.6
height of vegetation	1.9	2.4	3.2
vegetation interfaces	1.4	2.1	3.0
orientation to water	2.0	2.0	2.4
orientation to direction	3.6	2.2	3.9
total	18.3	21.5	27.4



numbers (Table 13) and on nearby Islands T and T<sub>1</sub> in large numbers. Terns did not nest elsewhere on Oliver Lake.

Three local residents with an interest in wildlife have been checking these islands for ten years. They informed me that during this period duck nests have always been as abundant as in 1968, and that there has always been a large tern colony associated with the islands. In 1966 they counted a total of 90 nests of ducks (mostly lesser scaup), common terns and avocets (*Recurvirostra americana*) on Island S, at one time.

In 1969, no terns nested on Oliver Lake, although suitable nesting areas were abundant. For the first time in ten years Islands R and S were unused by scaup and gadwall. One Canada goose and one mallard did establish nests.

I feel that the unusual density of nesting ducks resulted in part from an attraction to the terns, and that when the terns left the area, the attraction no longer existed. The reverse of this suggested association is not likely as the terns begin nesting earlier than do scaup. It is impossible to rule out the effect of some major environmental change which effectively made these islands unsuitable for both species, but it is difficult to visualize the nature of a change that would so drastically affect two ecologically different species.





#### IV-8. FREEDOM OF SELECTION FOR OPTIMAL CONDITIONS

It was assumed earlier that ducks had a completely free choice of nest sites, unaffected by the presence of established birds. This assumption is justifiable only if it can be shown that available nesting sites are not saturated by the numbers of ducks nesting on the islands. There are several lines of evidence for this.

The density of nests on many of the islands studied was higher than usual mainland averages. But they remained much lower than densities reported where nesting was successfully accomplished (Duebbert 1966). It was suggested (Section IV-2) that many suitable sites may be chosen by each hen before the definitive nest is constructed. If so, the fact that none of these sites was ever observed to be used later by any duck would seem to indicate that suitable sites were superabundant. It is evident that a site is unavailable for selection while it is occupied by a nesting duck. Once the nest has hatched, the site may become available again. In 1969, four nest sites were re-used by a different species after the first nest had hatched or been destroyed.

If nest sites were limited in number, it would be expected that sites with characteristics in the ranges most frequently used would be less available later in the nesting season. Data for 95 lesser scaup nests were arranged with their dates of initiation in chronological order. Five time classes were formed, each containing the initiation dates of 19 nests. Temporal patterns of selection for three nest-site characteristics were examined for trends of change during the nesting season.



It was seen earlier (p. 50) that lesser scaup selected vegetation which had physiognomic forms A, C, and F. Figure 36 indicates a temporal shift in the use of all three of these types. A progressive decrease in the use of Form F vegetation paralleled an increase in the use of Forms A and C. This likely reflects the fact that bulrush and gooseberry (Form F) are available early, while A and C Forms develop later in the season. This interpretation is compatible with the assumption stated at the beginning of this section. However, there exists the alternate interpretation that the increasing use of A and C vegetation reflects a progressive saturation of the available Form F vegetation.

Lesser scaup appear to prefer vegetation in the 1.5 to 3.4 dm height range (p. 60). In Figure 37, the only very evident shift is the increasing use of this range as the season progressed. There is an indication that very tall vegetation (Class 4) was used less later in the season despite its increasing availability. This likely reflects the fact that the best cover early in the season is provided by the tall gooseberry bushes.

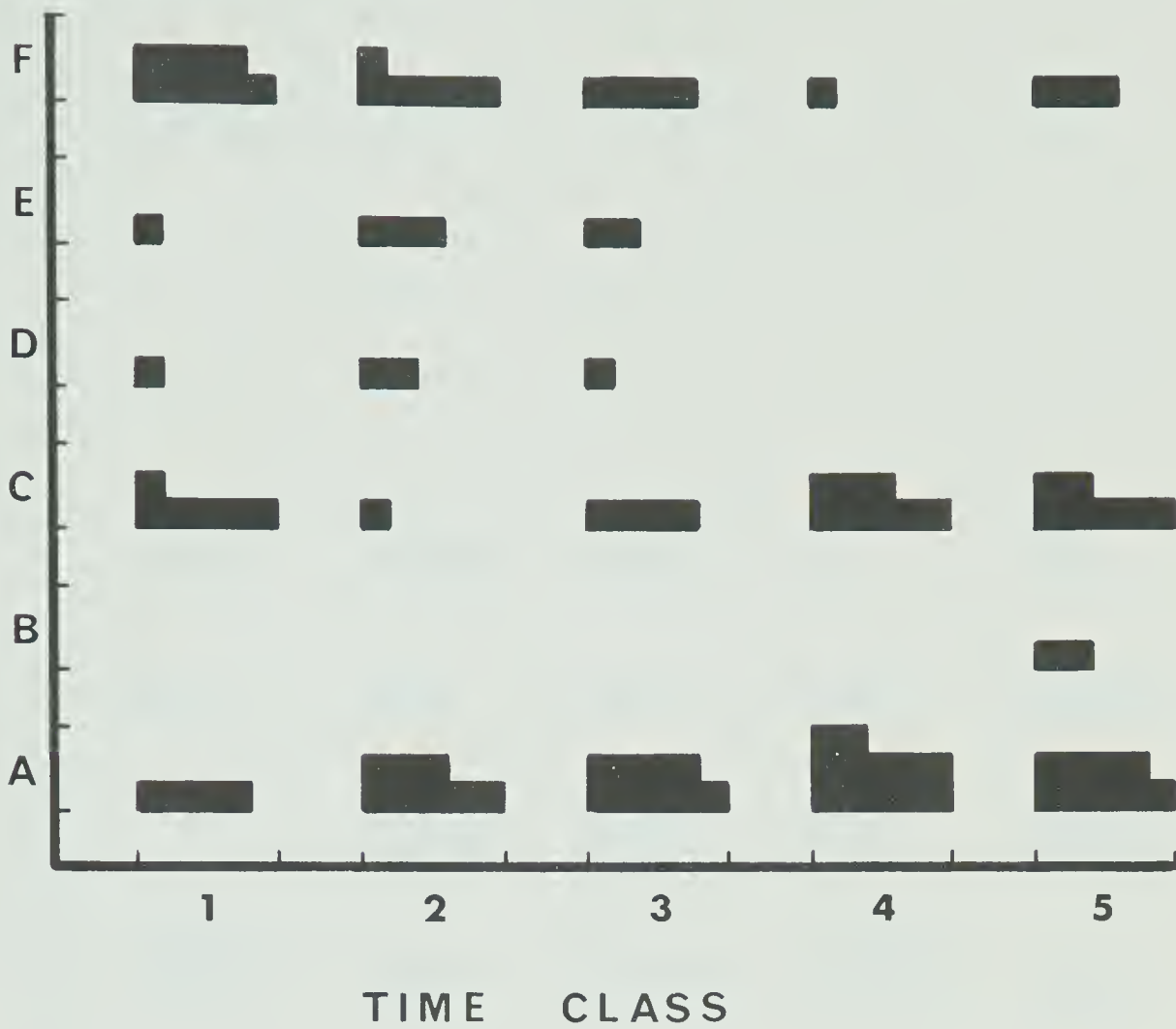
There is no evident shift in the utilization of different cover classes during the nesting season (Fig. 38).

This analysis suggests that it is unlikely that later nesting ducks are restricted in their choice of nest sites by the presence of earlier nesting birds. If anything, sites with the preferred characteristics become more abundant as the vegetation develops.

Figure 36. Numbers of nests of lesser scaup established in six physiognomic forms of vegetation during five portions of the nesting period. Time classes are of different lengths, each containing 19 nests.

Figure 37. Numbers of nests of lesser scaup established in four height classes of vegetation during five portions of the nesting period. Time classes are of different lengths, each contained 19 nests.

PHYSIOGNOMIC FORM



HEIGHT CLASS

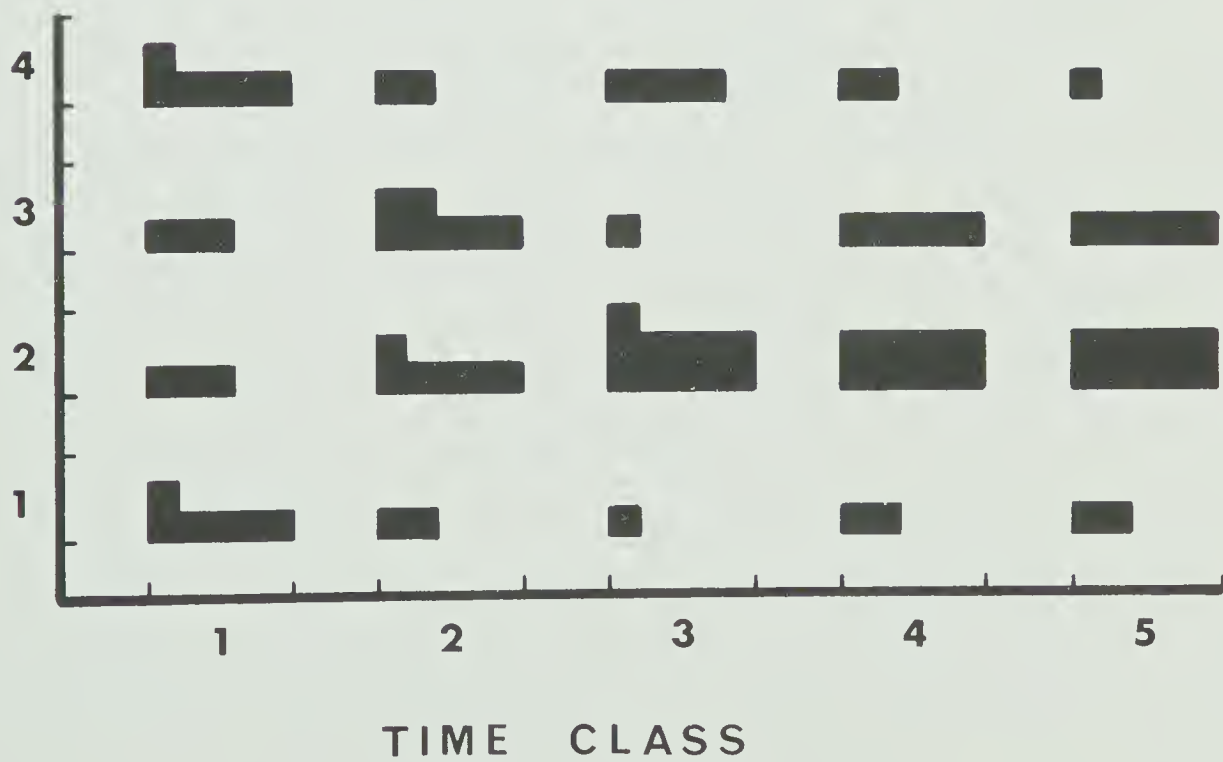
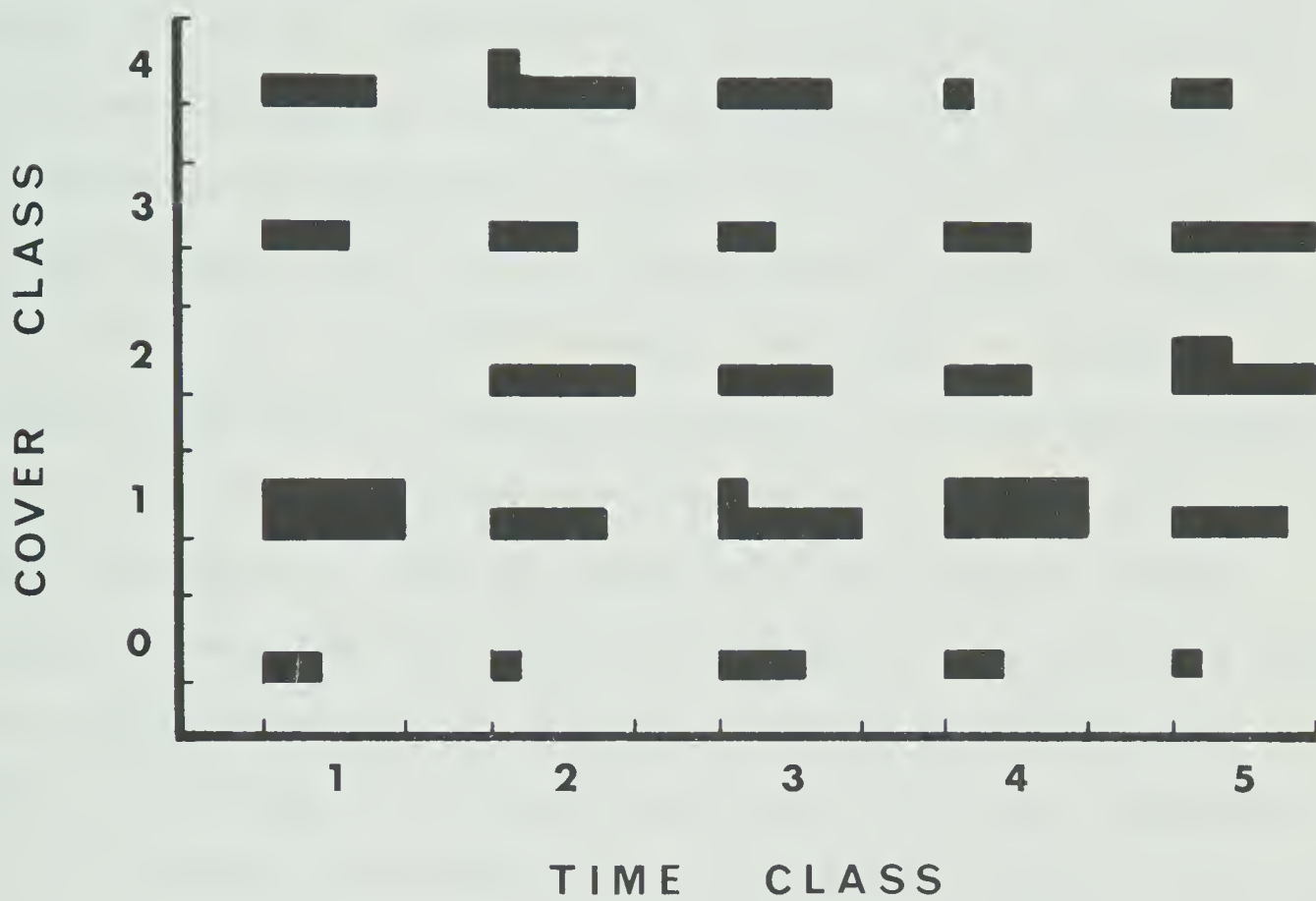


Figure 38. Numbers of nests of lesser scaup established in five classes of vegetative cover during five portions of the nesting period. Time classes are of different lengths, each containing 19 nests.







#### IV-9. NEST SITES AND NESTING SUCCESS

Nesting success has often been found to be higher for ducks nesting on islands than those using mainland sites. In this study, 212 of 305 nests of known fate were successful in hatching at least one egg. Nests on Islands S and R in 1968 are omitted from discussion because of the unusual situation there. The chief cause of nest failure in this study was predation by crows, with desertion, mammalian predation, and predation by other birds appearing to be insignificant. Over 45% of nests of known fate suffered some egg loss. Table 15 presents the rates of hatching success reported by several authors. In all island studies, with the exception of Dwernychuk (1968), over 70% of nests were successful. The low success in Dwernychuk's study probably resulted from human interference. On mainland areas, the highest success was reported by Mendall (1958) where 62% of marsh-nesting ring-necked duck nests were successful. In all dry-land mainland sites, the rate of success was less than 47%. This leaves little doubt that the island situation is superior to mainland habitats, as far as duck nesting success is concerned. The absence of mammalian predators is usually invoked to explain the difference (Hammond and Mann 1956, Townsend 1966).

For management purposes, it would be desirable to relate nesting success to measurable factors of the environment. In this study, no very obvious correlations were found.



Table 15. Duck nesting success reported in twelve studies of island or mainland nesting areas.

Authority	Number of clutches	Percent success	
		Island	Mainland
Harris (1954)	-	-	35
Duebbert (1966)	70	85	-
"	109	93	-
Mendall (1958)	290	78	-
"	190	-	62
Keith (1961)	18	83	-
"	115	-	20
Gates (1962)	-	-	47
Rogers (1964)	-	-	4
Lokemoen (1966)	-	-	15
Townsend (1966)	113	-	37
"	85	73	-
Vermeer (1968)	96	90	-
Dwernychuk (1968)	258	46	-
this study	305	70	-



Lesser scaup was the most successful species (80%), followed by the gadwall (69%) and mallard (63%). Townsend (1966) also found that diving ducks were more successful, and attributed this to their utilization of moist and floating nest sites, where predation would be lower. In this study, all nests were located in dry sites and the species were intermingled on the same habitat. Dwernychuk (1963) found dabblers more successful (57%) than divers (46%).

Nesting success over the range of habitats discussed in Section IV-3a is shown in Table 16. Success of scaup, or of all species combined, did not differ from a uniform distribution despite the fact that the different habitats differed widely in the nature of cover afforded. It appears then that general habitat type is unimportant in determining the rate of predation on duck nests.

Nesting success on the most heavily used islands of study area appear in Table 17. Islands B, M, and J had very high success, and on B and M this was probably attributable to the presence of gull colonies. On island A, 10 nests located within 30 m of nests of common terns contained a total of 92 eggs of which 71% hatched. In 28 nests located at a greater distance, 63% of 213 eggs hatched. I have observed ring-billed gulls and California gulls driving crows from their colonies. I have also observed common terns chasing both gull species, crows, red-tailed hawks (*Buteo jamaicensis*), marsh hawks (*Circus*





Table 16. Percent of anatid nests in which at least one egg hatched, in six types of habitat.

Habitat type <sup>a</sup>	1	2	3	4-5	6	7
lesser scaup	54(11) <sup>b</sup>	71(14)	89(22)	79(19)	85(13)	100(5)
all species	62(16)	69(32)	79(47)	76(42)	63(41)	82(11)

a

Type of habitat defined in Table 2

b

Number of nests

Table 17. Percent of anatid nests in which at least one egg hatched, on six heavily used islands.

Island	A	B	M	J	K	L
lesser scaup	60(30) <sup>b</sup>	94(17)	100(10)	100(14)	77(22)	100(2)
all species	60(48)	85(41)	93(14)	86(22)	65(43)	59(17)

b

Number of nests



*cyaneus*), great blue herons (*Ardea herodias*), and short-eared owls (*Asio flammeus*). Mendall (pers. comm.) states that nests of the common eider (*Somateria mollissima*) located within the territory of a herring gull (*Larus argentatus*) are usually more successful than those located on the same islands, but away from the gull colony. Koskimies (1957) has discussed the protective value of the association of ducks with gulls. These observations suggest that association with larids promotes successful duck nesting. However, predation by gulls on newly hatched ducklings may be severe (Vermeer 1967).

The different rates of hatching success on Islands J and A, K and L is more difficult to interpret. All were freely hunted by crows, and there were occupied crow nests on Islands K and L. Possibly the relatively homogeneous sedge and grass habitat of Island J was more difficult for crows to search thoroughly. Islands K and L had excellent cover, but also had abundant trees which provided look-out perches for crows. The close proximity of nesting crows on Islands K and L was no more detrimental to duck nesting than was periodic hunting by crows such as occurred on Island A.

The amount of concealing cover might affect predation, as crows hunt predominantly by sight. Dwernychuk (1968) reviewed the subject and found reported correlations both positive and negative. His own data showed no correlation when natural duck nests were studied, but predation



on dummy nests was correlated negatively with the degree of cover. The results of this study show no deviation from a uniform distribution of predation in five cover classes (Table 18).

The behavior of the incubating hen may account for the lack of consistent correlation. If ducks nesting in exposed sites tend to be more attentive than those in dense cover, the effects of the different degrees of cover might be neutralized. I considered the distance at which a duck flushed as an observer approached the nest as an indicator of each duck's affinity for her nest. For 188 lesser scaup nests and a pooled total of 214 nests, the median observation of flushing distance and the degree of cover were considered. There was no apparent correlation.

In Section IV-4d it was noted that height of vegetation appeared to be important to nesting ducks. Table 19 shows hatching success for nests in four vegetation height categories. There was no significant deviation from a uniform distribution among the categories.

Munro (1941) observed that nest loss decreased as the breeding season progressed, and attributed this to the higher vegetation offering better cover later in the season. Mendall (1958) presents similar results. In this study, nesting success was 87%, 78%, 75%, and 63% for nests initiated in April, May, June and July respectively. This is despite the fact that later nests were predominantly of lesser scaup, the species with the highest overall success.





Table 18. Percent of anatid nests in which at least one egg hatched, in five classes of cover.

Cover class <sup>a</sup>	0	1	2	3	4
lesser scaup	69(29) <sup>b</sup>	85(26)	83(18)	93(15)	43(7)
all species	69(65)	66(50)	80(35)	74(34)	64(14)

a Cover classes defined in Fig. 20  
b Number of nests

Table 19. Percent of anatid nests in which at least one egg hatched, in four vegetation height classes.

Height class <sup>a</sup>	1	2	3	4
lesser scaup	77(13) <sup>b</sup>	70(43)	94(17)	87(15)
all species	74(27)	71(70)	76(38)	70(49)

a Height class defined in Fig. 24  
b Number of nests



If inexperienced birds tend to nest later than older birds (Grice and Rogers 1965; Morse and Wight 1969; Morse, Jakabosky and McCrow 1969) increased loss later in the season may be correlated with the higher proportion of novice birds on the nesting grounds. This is supported by the fact that all species, whether early or late nesters, showed this same terminal decrease in hatching success.

The results of this study provide little information on the factors which affect predation on duck nests, although it appears that factors concerning vegetation are of secondary importance to the island situation itself, and to the presence or absence of aggressive species such as terns.





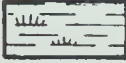

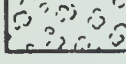


## V. CONCLUDING DISCUSSION

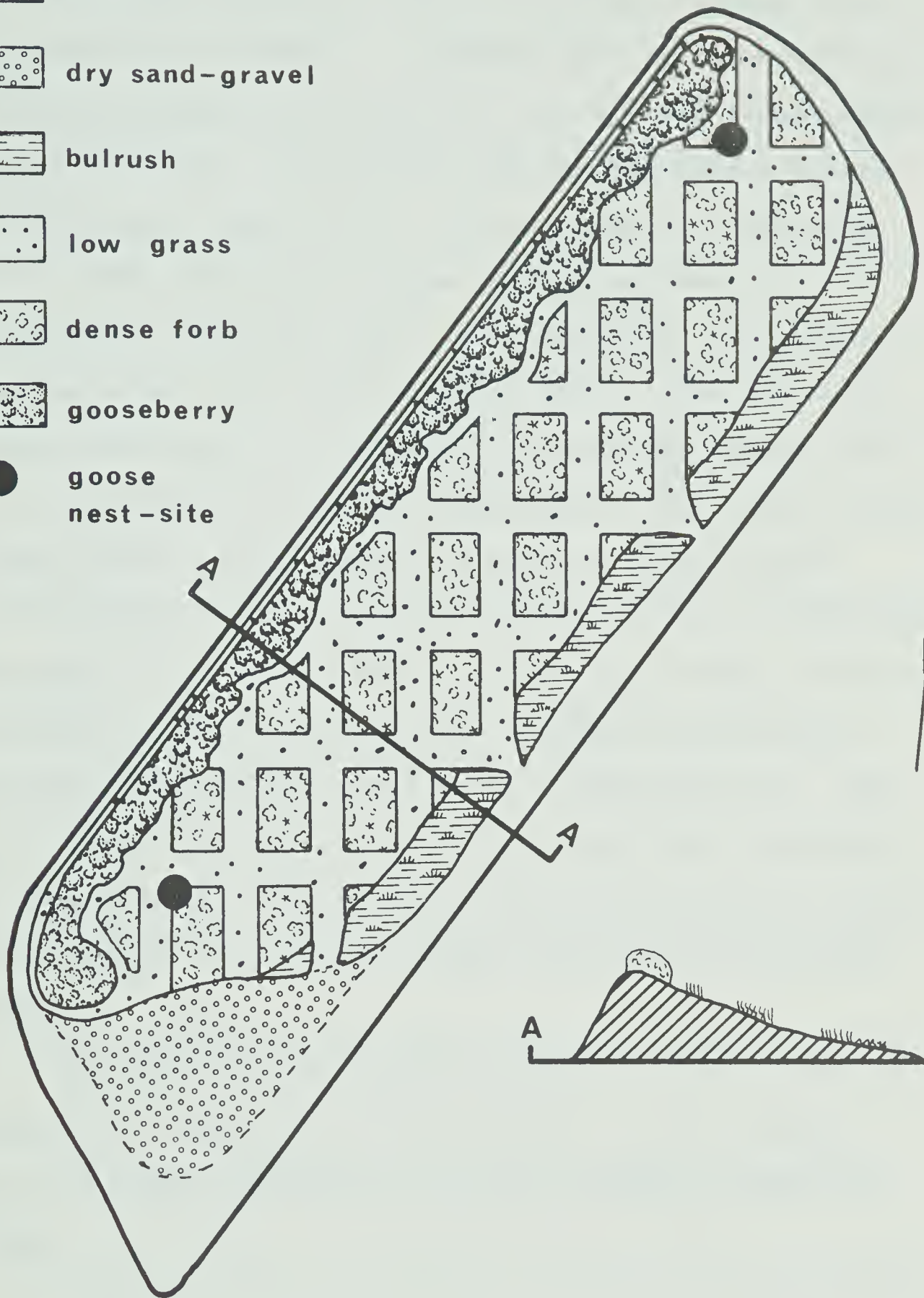
This study was designed to investigate the role of certain specific properties of the environment in directing the selection of nest sites by ducks. In the absence of background information on the subject the study was restricted to a correlative approach. This approach can seldom lead to the formulation of firm conclusions, but is a necessary forerunner of experimental work. The results presented suggest types of factors that should be examined experimentally.

A physiognomic classification of vegetation appears to be more relevant to selection than taxonomic classification. Height of vegetation seemed more relevant to selection than was the degree of cover. Both the heterogeneity of the habitat, and the direction of exposure of nest sites appeared to be important to selection. Associations with larids and geese were suggested. The significance of each of these factors remains speculative; the establishment of their true importance will require precise experimental study.

An understanding of the specific environmental factors important to nesting waterfowl would provide the necessary basis for practical tailoring of the environment for maximal waterfowl production. As an illustration of the use of such information, a model island was designed, based on the results of this study (Fig. 39).

Figure 39. A model island designed on the basis of the results of this study to encourage maximal use and production by nesting waterfowl.

-  sand
-  dry sand-gravel
-  bulrush
-  low grass
-  dense forb
-  gooseberry
-  goose nest-site







The model island is long and narrow, running from southwest to northeast. In section A-A it rises abruptly on the northwest to a height of 3 to 5 m and slopes gently to the southeast. This shape and the gooseberry bushes along the crest shelter the island from the prevailing wind. They also provide a maximal coincidence of orientations to water and to the southeast, and abundant loafing areas along the southeast shore. The southern area of dry sand and gravel might encourage common terns to nest, and two artificial goose nest sites might attract Canada geese. The presence of both of these species would make the island more attractive to ducks, and would also make it safer for their nesting activities. Alternating patches of dense forbs and short (mowed?) grass would provide abundant cover, and maximal heterogeneity. The stand of bulrush would provide residual cover for early nesting species. Gooseberry bushes form excellent nesting cover, and do not provide lookout perches for marauding crows.

The results of this study suggest that an island constructed according to this design, in this region, would be used successfully by large numbers of nesting ducks.



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APPENDIX I

Daily maximum and minimum temperatures and precipitation recorded at Miquelon Lake during the 1968 and 1969 study periods.

Date		Temperature (°F.)				Precipitation (in.)	
		max.		min.			
		1968	1969	1968	1969	1968	1969
May	1	-	-	-	-	-	-
	2	-	67	-	42	-	0
	3	-	-	-	-	-	0.12
	4	-	62	-	38	-	0
	5	-	-	-	38	-	tr.
	6	-	50	-	34	-	0
	7	-	54	-	30	-	0
	8	-	68	-	36	-	0
	9	-	58	-	34	-	0
	10	-	60	-	25	-	0
	11	-	64	-	42	-	0
	12	-	66	-	30	-	0
	13	-	66	-	44	-	0.03
	14	-	40	-	35	-	0.1
	15	-	60	-	24	-	0
	16	-	53	-	27	-	0
	17	-	57	-	33	-	0
	18	-	48	-	40	-	0
	19	-	44	-	28	-	0
	20	-	43	-	21	-	0
	21	-	60	-	42	-	0
	22	-	63	-	40	-	0
	23	-	64	-	33	-	0
	24	64	71	46	48	0.01	0
	25	66	67	45	42	0.4	0
	26	67	52	36	37	-	0.13
	27	62	48	42	37	0.34	0.02
	28	66	53	41	37	0.05	tr.
	29	61	58	39	37	0	tr.
	30	60	-	36	26	0	0
	31	60	-	30	-	0	0
June	1	69	-	36	-	0	0
	2	67	68	42	-	tr.	0
	3	65	68	45	42	0	0
	4	67	70	39	41	0	0
	5	60	72	46	36	0.02	tr.
	6	66	55	-	35	0	0.04

(continued)





Appendix I (continued)

Date		Temperature (°F.)				Precipitation (in.)	
		max.		min.			
		1968	1969	1968	1969	1968	1969
June	7	66	60	43	35	0.05	0
	8	65	66	46	40	0	0
	9	70	69	48	41	0	0
	10	73	64	44	30	0	0
	11	74	46	48	30	0	0
	12	63	51	51	20	0.04	0
	13	48	56	33	24	0.18	0
	14	57	-	27	-	0	0
	15	66	68	27	44	0	0
	16	70	71	33	35	0	tr.
	17	66	75	37	41	0.04	0
	18	71	76	33	50	tr.	tr.
	19	68	50	55	38	0.47	0
	20	58	56	41	34	0.4	0
	21	65	-	33	-	0	0
	22	69	62	35	34	0	0
	23	55	65	41	38	0.03	tr.
	24	68	55	35	38	0	0
	25	75	62	48	38	0	0
	26	80	62	46	39	0	0
	27	70	66	51	40	0.03	0
	28	-	60	41	45	0	0.18
	29	46	63	39	45	0.71	0.15
	30	68	53	39	43	0	0
July	1	71	62	42	30	0	0
	2	-	70	40	38	0	0
	3	79	60	48	43	0	0.08
	4	83	58	46	36	0	0.93
	5	-	55	48	45	-	0.25
	6	-	50	-	44	-	0.49
	7	-	55	-	46	-	0.15
	8	-	64	-	39	-	0.05
	9	-	71	-	41	-	0
	10	-	73	-	49	-	0
	11	-	64	-	49	-	0
	12	-	62	-	41	-	0
	13	70	60	51	38	0	0
	14	-	62	36	36	0	0
	15	70	60	48	33	0.1	0
	16	69	63	41	39	tr.	0.05
	17	68	63	38	38	tr.	0

(continued)



Appendix I (continued)

Date		Temperature (°F.)				Precipitation (in.)	
		max.		min.			
		1968	1969	1968	1969	1968	1969
July	18	72	67	37	35	0.07	tr.
	19	66	67	43	37	tr.	0
	20	60	70	49	40	0.69	0.98
	21	67	67	46	44	0	0
	22	65	69	42	40	0.01	0
	23	65	69	39	45	0	0
	24	69	73	40	38	0	0
	25	75	62	43	50	0.18	0.11
	26	-	-	-	-	-	-
	27	-	-	-	-	-	-
	28	-	-	-	-	-	-
	29	-	-	-	-	-	-
	30	-	-	-	-	-	-
August	1	72	68	49	45	0.08	0
	2	66	70	49	44	0.05	0.17
	3	75	66	42	46	0	0
	4	73	68	50	48	0.09	0.03
	5	-	-	-	50	-	-
	6	-	-	-	-	-	-
	7	50	-	-	-	0	-
	8	58	-	40	-	0	-
	9	61	-	31	-	0	-
	10	68	-	35	-	0	-
	11	68	-	45	-	tr.	-
	12	67	-	35	-	0	-
	13	61	64	27	32	0	0
	14	67	72	42	44	0	0
	15	63	70	37	42	0	0
	16	64	52	32	32	0	0
	17	69	59	43	32	0	0
	18	-	58	-	35	-	0
	19	-	62	-	40	-	0
	20	-	66	-	35	-	0



## APPENDIX II

Details of method of application of Chi-squared tests to the results of this study.

Chi-squared tests were applied to data in two principal ways. For data such as appear in Fig. 16, the number of nests of each species, in each class, was compared to the number of random points in that class in a 2 x 2 contingency test.

Data for the entire study area in 1969 (Fig. 17) did not include information on the availability of habitat. It was therefore only possible to compare the species, with respect to the distribution patterns of their nests in the different categories of habitat. This was done by formulating a null hypothesis such as, gadwall do not differ from scaup. The proportion of scaup nests was then used to calculate the expected number of gadwall nests in each class. These expected values were then compared to the observed number of gadwall nests in a goodness of fit test, with the number of degrees of freedom being one less than the number of classes.





APPENDIX III

Procedure used in attempted quantification of the quality of duck nest sites.

The procedure involved the scoring of nests on certain measured characteristics. The value of each characteristic was assessed on the basis of its occurrence at duck nests over the entire 1969 study area. These values appear in parentheses in the table below. They were calculated as in the following example:

Consider type of habitat. There were eight types, so the habitat factor was assigned a weight of 16 points (2 x 8). Reference to Table 6 shows that 12% of all nests were situated in Habitat Type 1. The value of this type was calculated as:

$$\frac{12}{100} \times 16 = 1.9$$

Similarly, 27% of nests were in Type 5 habitat so this type was assigned a value of 4.2 (27% of 16).

When nests were scored, they received 3.8 points for being in habitat 3, 3.2 points for being in vegetation between 1.5 and 3.5 dm high, 3.9 points for being oriented to the southeast, and so on. The maximum possible score was 27.4, assigned to a nest that occurred in the most preferred category of each characteristic.

(continued)



Appendix III (continued)

Factor	Class values								Total
Type of habitat	1 (1.9)	2 (2.4)	3 (3.8)	4 (0.3)	5 (4.2)	6 (2.6)	7 (0.6)	8 (0)	16
Physiognomy of veg.	A (4.2)	B (0.7)	C (4.0)	D (0.5)	E (1.0)	F (3.2)			12
Cover value	0 (1.3)	1 (2.8)	2 (2.4)	3 (1.6)	4 (1.8)				10
Light interception	1 (0.1)	2 (0.6)	3 (1.9)	4 (3.5)	5 (3.6)				10
Height of vegetation	1 (1.2)	2 (3.2)	3 (1.8)	4 (1.4)					8
Distance to inteface	1 (1.0)	2 (3.0)	3 (1.9)	4 (0.8)					8
Orientation to water	towards	(2.4)		away	(1.6)				4
Orientation to direction	NW (2.1)	NE (3.0)	SE (3.9)	SW (2.5)					8











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